9

FIRST BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR OF UTAH.

1897 AND 1898.

SALT LAKE CITY.
The Deseret News.
1899.

CONTENTS.

SALT LAKE CITY, UTAH,
December, 27th, 1898.

Honorable Heber M. Wells, Governor of Utah.

SIR:—In compliance with Section 2458, Chapter 8, Revised Statutes of Utah, 1898, I have the honor to submit a report of the work of this office during the past two years, with such recommendations as to amendments of the existing laws relating to irrigation and the enactment of new laws as will, I trust, promote the public welfare.

Respectfully,
ROBERT C. GEMMELL,
State Engineer.

APPOINTMENTS.

On April, 1st, 1897, Mr. Willard Young, having been duly appointed to the office, assumed the duties of State Engineer of Utah. After war was declared against Spain, Mr. Young resigned, to become Col. of the 2nd Regiment of U. S. Volunteer Engineers. On August 1st, 1898, the writer was appointed to fill the vacancy caused by the resignation of Mr. Young.

Work of Office in 1897-1898.

PREPARATION OF PLANS.

Section 2451 of the Revised Statutes provides that the State Engineer shall, under the direction of the Board of Land Commissioners, prepare plans and specifications for, and have general supervision over, any works relating to irrigation in which the State may have any interest. No work of this kind has yet been attempted by the State.

RECORD OF STREAM MEASUREMENTS.

Section 2452 provides that the State Engineer shall keep a record of measurement of streams, etc. No provision is made, however, whereby he is enabled to measure the streams. The office, therefore, can only keep records of such measurements as have been, or may be, made by the United States Government. This is being done.

APPROVAL OF PLANS.

Section 2453 provides that all plans of dams or dikes, where the same are more than ten feet in height, shall be approved by the State Engineer. No provision is made, however, to enable him to see that the plans and specifications are carefully observed. He could not, therefore, be held responsible in any way for any failures. Still, this section of the law has been of service to the people, as it has given them the benefit of consulting engineering advice free of charge. State supervision of the construction of dams would be an expensive and too serious a burden upon the State.

The following is a list of dams, the plans and specifications for which have been approved by this office:

The dam of the Otter Creek Reservoir Company is located on Otter Creek in Sec. 28, T. 30 S., R. 2 W., Piute Co., at a point about 100 yards above the junction of Otter Creek with the East Fork of the Sevier river. The general plan for this dam was approved on Nov. 2nd, 1897, by Mr. Willard Young. The maximum height is to be 40 feet; maximum width at base, 210 feet; width on top, 30 feet; length on top, 1200 feet. The dam is to be a combination of a homogeneous earthen dam on the upstream side with a loose rock dam on the downstream side. The upstream slope is to be 3 feet horizontal to 1 vertical, and the downstream slope 1½ feet horizontal to 1 vertical. The wasteway is to be over solid rock at the North end of the dam, and the water is to be drawn from the reservoir through a tunnel in solid rock at the South end of the dam. The reservoir formed by this dam will have a surface area of 2179 acres and a storage capacity of 41,071 acre feet of water. The dam is being constructed by the farmers of Sevier and Piute counties, who work upon it during the Spring and Fall months. They hope to have it completed by January, 1st, 1900. The top of the dam, after completion, will form a part of the county road.

The main dam of the Deseret and Salt Lake Canal Company is located on the Sevier river, near Oasis, in illard county, Section 10, T. 16 S. R. 6 W. It is a homogeneous earthen dam, with upstream slope of 4 feet horizontal to 1 vertical and downstream slop of 1½ feet horizontal to 1 vertical. The maximum height is 20 feet; maximum width at base, 140 feet; width on top, 30 feet; length on top, 1200 feet. A second dam had to be built where a narrow neck of prairie 200 feet wide separating two bends of the river had been cut through. The dimensions of this dam are practically the same as those of the main dam, except that its length is only about 150 feet. The wasteway is through a wooden flume, 5 feet deep and 100 feet wide, located about 1 mile Southeasterly from the main dam. The water is drawn from the reservoir through canals provided with suitable headgates. The reservoir formed by the dam has a surface area of 940 acres and a storage capacity of 10,000 acre feet. The construction work was completed during the summer of 1898.

The dam of the the Davis and Weber Counties Canal Company is located on East Canyon Creek in Sec. 10, T. 2 N., R. 3 E., Morgan county. The general plan of this dam was approved Aug. 15th, 1898. The maximum height is to be 68 feet; maximum width at base, 202 feet; width on top, 15 feet; length on top, 100. The dam is to be of the type known as a rock-filled dam, on a foundation of Portland cement concrete reaching to bed-rock. Imperviousness is to be secured by means of a center core wall of riveted steel plates imbedded in asphalt concrete, both of which extend from the foundation to the top of the dam. The up-stream slope is to be $\frac{2}{3}$ ft. horizontal to one vertical, and the down-stream slope is to be 2 ft. horizontal to 1 vertical. The wasteway is to be over solid rock at the South end of the dam, and the water is to be drawn from the reservoir through a tunnel in solid rock at the North end of the dam. The reservoir formed by this dam will have a surface area of 280 acres and a storage capacity of 13,840 acre feet. The dam is now under construction and will be completed this winter.

The dam of Payson City reservoir is located in Petetneet Canyon, near the source of stream of same name, in Utah county. The maximum height is 30 feet; maximum width at base, 100 feet; width on top, 10 feet; length on top, 475 feet. It is a homogeneous earthen dam, with up-stream slope 3 feet horizontal to 1 vertical and down-stream slope of 2 feet horizontal to 1 vertical. The wasteway is near the Southwesterly end of the reservoir, over a saddle or divide leading into another fork of the canyon, and the water is drawn from the reservoir through an 8 inch cast iron pipe laid through the embankment. The reservoir formed by this dam has a surface area of 29.1 acres and a storage capacity of 214 acre feet. The dam was built last summer for the purpose of increasing the water supply of Payson City.

The Sandridge Reservoir and Canal Company's dam is located in about the center of San Pete county, near the town of Ephraim. It is a homogeneous earthen dam, with upstream slope of 3 feet horizontal to 1 vertical and downstream slope of 1½ feet horizontal to 1 vertical. The maximum height is 23 feet; maximum width at base, 114 feet; width on top, 10 feet; length on top, about 600 feet. The wasteway is to be over solid rock near the West end of the dam, and the water is to be drawn from the reservoir through a 16-inch wood stave pipe laid through the enbankment. The reservoir formed by the dam has a surface area of 80 acres and a storage capacity of 1,200 acre feet. The dam is being built by the farmers and will be completed during the spring of 1899.

The Donkey Creek Reservoir Company's dam is located in Wayne county, south of the town of Teasdale. It is constructed of loose rock, timber and earth. The maximum height is 15 feet; maximum depth of water, 12 feet. The reservoir formed by the dam has an area of 80 acres and a storage capacity of 400 acre feet.

The total storage capacity of the six reservoirs above described is 66,724 acre feet. After allowing for losses by seepage and evaporation, this amount of water, if properly handled and controlled, should redeem at least 33,000 acres of land.

For the benefit of dam builders, and for the sake of securing uniformity in the plans and specifications to be filed in this office, full instructions regarding the preparation of the same have been printed. A copy of these instructions is attached to this report, marked Exhibit "A."

INSPECTION OF DAMS.

Section 2455 provides that "The state engineer shall inspect, or cause to be inspected, as often as he thinks advisable, every dam or embankment used for holding water in this State, where the same is more than 10 feet in height, etc." This has been done. Two dams have been repaired, and the construction of one has been stopped, by the orders of this office.

INFORMATION AS TO WATER MEASUREMENTS.

Section 2457 provides that the State Engineer shall give information as to measurements of water to anyone desiring it, and, further, that he "Shall give special instructions to all watermasters as to measurements of water, so as to secure a just distribution of the same."

People in all parts of the State have taken advantage of the first clause of this section, and this office has cheerfully furnished the information desired. It has been very gratifying to the State Engineer to find so many people anxious to learn about the methods of measuring water accurately.

The latter clause of this section has given the engineer as much, if not more, work than all of his other duties combined. It would be quite impracticable to instruct all of the watermasters in the state by word of mouth, and the engineer has, therefore, prepared and published a pamphlet upon the subject. Letters have also been addressed to every mayor and every postmaster in the State, asking for names and addresses of watermasters. It is hoped to soon have a complete list of all watermasters in the State. As fast as names and addresses are received, copies of the pamphlet will be sent to watermasters free of charge.

This pamphlet gives full explanations as to the accuracy and usefulness of the weir method of measurement. It states the conditions necessary for accurate measurement; explains fully how to measure the head of water upon a weir, and how to construct a weir, giving a sufficient number of illustrations and plans to make the text clear to anyone. It also gives full explanations as to modules, divisors, and the method of distribution of water by time. The latter half of the book (about 30 pages) consists of tables, giving discharges in cubic feet per second over rectangular weirs and Cippoletti trapezoidal weirs. Very few watermasters in Utah are engineers, and it was thought best to so construct these tables that the discharges might be read without the necessity of making any calculations whatever. This made a great deal of work for this office, involving, as it did, thousands of computations. It is believed that these weir tables are the most complete that have ever been published, and it is hoped that watermasters will make good use of them. A copy of the pamphlet is enclosed with this report, market Exhibit "B".

FEES FOR EXAMINATIONS.

Section 2459 provides that the State Engineer shall collect fees for services rendered in the location or examination of dam sites, etc. The following fees have been collected by this office:—

April 2nd, 1897. Holmes Creek Irrigation Company	$ 4 00
April 9th, 1897. Theo. Brandley, Mayor of Richfield	12 00
April 10th, 1897. Sevier County Court	4 00
July 6th, 1897. South Jordan Canal Company	4 00
July 13th, 1897. George Taylor	4 00
Sept. 14th, 1897. W. D. Robinson, Mayor of American Fork	4 00
Sept. 22nd, 1897. Beaver Creek Irrig. and Reservoir Company	8 00
Sept. 24th, 1897. Otter Creek Reservoir Company	8 00
Feb'y 12th, 1898. Davis and Weber Counties Canal Company	4 00
Sept. 1st, 1898. City of Monroe	8 00
Sept. 2nd, 1898. Sandridge Reservoir and Canal Company	4 00
Nov. 1st, 1898. Davis and Weber Counties Canal Company	4 00
Nov. 1st, 1898. Salt Lake and Deseret Reservoir and Canal Company	10 00
Total Amount of Fees Collected	$78 00

The above amount has been turned into the State Treasury. No fees have been charged the reservoir companies for advice, except in cases where the engineer was called upon to leave the city, in order to personally examine the reservoir sites.

EXPENDITURES.

Section 2451 provides that the sum to be expended for expenses of the office shall not exceed five hundred dollars per year. The following is a list of the expenses incurred during 1897-1898:—

EXPENSES FOR 1897-1898.

May 4th, 1897. Geo. Q. Cannon & Sons Co., Supplies	$ 20 32
May 4th, 1897. Z. C. M. I., Letter Press	7 50
June 26th, 1897. Geo. Q. Cannon & Sons Co., Supplies	3 75
June 26th, 1897. Utah Lithographing Co. Letter Heads	20 50
June 26th, 1897. Deseret News Co., Envelopes	26 50
July 29th, 1897. Willard Young, Traveling Expenses	73 60
Aug. 23rd, 1897. Margetts Bros., Supplies	20 55
Oct. 26th, 1897. Willard Young, Office Expenses	14 25
Dec. 18th, 1897. Margetts Bros., Office Expenses	110 00
Jan. 18th, 1898. Willard Young, Office Expenses	8 35
Jan. 18th, 1898. Engrg. Dept. S. L. C., Services	21 75
Feb. 24th, 1898. C. R. Savage, Supplies	12 20
April 21st, 1898. E. M. Cornell, Services	6 00
June 24th, 1898. City Engr. S. L. C., Supplies	4 30
Nov. 2nd, 1898. Deseret News, Circulars	8 00
Dec. 27th, 1898. Deseret News, Envelopes	27 40
Dec. 27th, 1898. Deseret News, Circulars	2 75
Dec. 27th, 1898. Wm. Spencer, Checking Weir Tables	100 00
Dec. 27th, 1898. O. H. Spencer, Typewriting report	10 00
Dec. 27th, 1898. Deseret News, "Instructions to Watermasters"	273 00
Total Amount of Expenses Incurred	**$770 72**

IRRIGATION INVESTIGATIONS.

In connection with what I am going to say regarding the irrigation laws of Utah, I desire to quote a part of the Report of the Director of the Office of Experiment Stations for 1898 upon "Irrigation Investigations," as follows:

"The following statements, taken from a recent communication of Professor Mead of this office, may serve to show some of the ways in which the department may profitably work and the largeness of the interests and problems requiring its aid in the irrigated region:"

"The first purpose of this investigation is to aid farmers now living on irrigated land."

"To do this it is proposed to collect and publish the available data relative to water rights, this to include the methods of acquirement, the control of streams and ditches by States and individuals, and a discussion and publication of the laws and methods of using and distributing water in the several arid States and in other countries. The need of this information and of a better understanding of our situation than the great mass of farmers now have is imperative. The diversion and control of streams have created a number of new and novel problems for which lawmakers, courts, or farmers have as yet no adequate solution. These are already assuming an importance which makes it manifest that the security of the irrigated home and the success of settlers on irrigated land are destined to depend largely upon their settlement. In irrigated regions values do not inhere in land, but in the water which fertilizes it. No amount of industry or skill on the part of the husbandman will bring a satisfactory return unless with it there goes effective and just control of the stream from which he and others draw their common supply. In this matter the individual is helpless. His success depends on his obtaining his proper share of the water supply, and this does not rest on his own efforts, but on proper administrative regulations. Our lack of knowledge of these facts and the comparative rapidity of our development have caused the use of water to outrun laws to govern its economical use or just disposition.

As a result, irrigated farms are threatened with controversies and litigation which, if not averted, must prove disastrous. * * Courts and lawmakers hesitate to deal decisively with these questions, because they have not the requisite knowledge on which to base conclusive legislation. The department of agriculture can do the West no greater service than to aid in putting the knowledge we already have in available form."

"There is need of a systematic investigation to determine the volume of water used in the growth of crops, both to determine the requirements of different crops and of different climates and to determine the relation between the variations in the demands of crops and the fluctations in the flow of streams. This information is needed as a basis for the proper division of streams by administrative officers. It is needed by canal builders in order to properly design these structures. It is needed by farmers to promote the saving of water, and thus limit losses through an inadequate supply or extend the acreage which can be cultivated. It is most seriously needed, however, to guide in the making of just and proper water-right decrees. In the disposal of streams courts cannot now properly fix the volume to which appropriators are entitled. Until they know how much water irrigators use, they cannot decide how much they should receive."

"These measurements should be made to show the utility of storage reservoirs and the part they can be made to perform in both saving the crops of farmers now along streams and making it possible for others to settle there. Without a definite knowledge of the variations which exist between the use of water in different months of the irrigation season and the fluctuation in the discharge of a stream, we can only conjecture as to the amount of flood water available for storage. A recent investigation of this question shows an almost entire absence of data on this subject. In only three states have there be any public determinations of the volume of water actually used in irrigation, and these have neither embraced the range nor been continued over a sufficient period to enable them to be regarded as conclusive."

"The objects of the work which this office has undertaken regarding the laws and institutions of the irrigated region are: (1) To aid courts and administrative officers in the adjudication of claims respecting water rights; (2) to bring out the defects in existing laws and methods of administration, and to furnish impartial and adequate information on which wiser and more equitable legislation and court decisions may be based, and (3) to assist farmers in the acquirement of water rights and to protect their interests in the appropriation and use of water for irrigation."

This should be good news for every farmer in Utah, but in order that they may take advantage of the information thus obtained, the State of Utah must herself take some action in the direction of forming new irrigation laws.

NEEDED LEGISLATION.

If we do not take into account the irrigators of pre-historic times, we may safely say that the people of Utah were the first to practice the art of irrigation in this country. This being so, we would naturally expect Utah to be the most advanced of any State or Territory in the Union on the question of irrigating laws governing the title to, and the just distribution of, the waters of the State. On the contrary, unfortunately, we find that she is probably the least advanced in these respects.

Water is personal property in Utah, and yet a very small percentage of the irrigators of Utah have undisputed, legally defined claims to water rights. So far as the writer is able to judge, it is necessary in this State to go into the courts in order to acquire titles to water. This is not only a very expensive method, but it is also one that requires much time. The trial of *one case* sometimes costs as much as would be required to run a properly organized State Engineer's office and Board of Control for an *entire year*, and a case that could be adjudicated in a couple of months by a Board of Control may require two or three years time to be decided by the courts. Again, the trials of water cases are often mere farces. This is not intended as a reflection upon the courts. So far as the writer's observation goes, the attorneys and judges always endeaver to get at the truth, but the character of the testimony is such that it is impossible to obtain a just and proper decree. How is it possible to properly decide a case, when the very evidence upon which the decree should be based is unobtainable? This is owing to the fact that we have no series of stream measurements and no reliable information as to the duty of water. The last question should be accurately solved for each case, as some soils and some crops require more water than others.

Generally, the testimony introduced as to the duty of water is of the following kind:

Q. Mr. Smith, for how long a time have you farmed in this locality?

A. About 15 years.

Q. Do you think you have a pretty good idea as to the duty of water for this particular section?

A. Yes, sir.

Q. How large is your farm, Mr. Smith?

A. Forty acres.

Q. How much of it do you irrigate?

A. About 35 acres.

Q. And how much water do you require in order to produce a good crop?

A. One good irrigating stream.

Q. Flowing constantly.

A. Yes, sir.

Q. Now just what do you mean by the expression "One good irrigating stream"?

A. I mean a stream 10 inches wide and 5 inches deep.

Q. Yes, and what quantity of water will such a stream give?

A. Fifty inches.

Q. Fifty cubic inches per second?

A. No, sir; fifty square inches.

Q. But, Mr. Smith, you cannot measure volumes of water in square inches. Can you not state to the court about how many cubic feet per second such a stream would discharge?

A. No, sir; we never measure water that way.

Q. Can you not state about what the mean velocity of the water in such a stream would be?

A. No, sir; never measured it.

Q. Well, then, how *do* you measure this stream which you call "fifty inches"?

A. In a box about 10 inches wide, 6 inches deep and 6 feet long.

Q. And how much fall do you give to this box?

A. A few inches.

Q. But that is indefinite. Can you not state just how much fall the particular measuring box on your farm has?

A. Well, you see it is this way: When we put the box in, we may give it, say, a fall of about 2 inches; then perhaps the water slops over and washes out the ditch and lets the lower end of the box down 3 or 4 inches, so that the fall is 5 or 6 inches.

Q. And you still call the discharge fifty inches, no matter whether the box has a fall of 2 inches or 6 inches?

A. Yes, sir.

Q. That is all, Mr. Smith.

Then, perhaps, an engineer is put on the stand to testify as to what the duty of water would be, if, to irrigate *about* 35 acres, it requires a stream *about* 10 inches wide and 5 inches deep flowing through a box *about* 6 feet long, with a fall of *about* 2 to 6 inches in its length. This is a fair sample. Days may be consumed in eliciting such testimony, and when it is all in, no proper evidence has been obtained upon which to base a decree.

Professor Elwood Mead, State Engineer of Wyoming, who has achieved a wide reputation as a student of irrigation problems in the West, has been selected as consulting expert and chief assistant in planning and carrying out the irrigation work which the office of Experiment Stations has undertaken. He has already made a study of the irrigation laws of Utah, and I desire here to quote from his preliminary report, as follows:

"The irrigation laws of Utah affect a larger percentage of her people than do those of any other arid State. The irrigated farms are small, and, with rare exceptions, are owned by the people who cultivate them. They are exceedingly productive, and are rapidly enhancing in value." * * *

"Titles to water are, therefore, of greater importance than deeds to land, and they should be created with the same care and tested by the same standard. It also seems necessary that, like deeds, they should be a matter of record so that the asserted ownership shall be notorious and that both the extent and location of the right should be a part of this record. A rigid definition of these titles and a special tribunal for their adjudication and protection are an especial necessity in Utah where, through usage and court decisions, the long-established principles of common law governing rights to streams have been set aside. Not only have the special rights of riparian proprietors been abrogated, but the territorial statutes have gone farther than those of any other arid commonwealth in making water personal property and in recognizing private and speculative ownership in streams.

"If rights to water were limited to irrigation; if they were inseparable from the land where acquired and only the right of use was recognized, the failure to make them a matter of record, or to establish definitely their amount, might not be serious, since the land itself would furnish a means of determining who were entitled to the use of streams, and the necessities of this land, which could at any time be ascertained, would govern the extent of the right; but when there are other users; when both mines and factories are recognized appropriators of water, and where the volume required, unlike the watering of land, may fluctuate widely from year to year, increasing in volume as the supply becomes more valuable and its possession more important; when cities and towns are each year absorbing a larger percentage of streams; when power plants are changing the places of diversion and interfering with the natural flow of streams; when the appropriations for irrigation are being so changed by sales or exchanges that their original character becomes a matter of uncertainty, then adequate measures for the determination of these rights and laws which will limit them to the actual volume originally applied to bene ficial uses become an absolute necessity, if the stability and value of the irrigated home is to be preserved."

"It is an astonishing fact, but one which has to be recognized, that Utah has never provided for the gaging of the streams used by appropriators, to show how much water they carry; nor made, or required to be made, any survey of the ditches and canals claiming vested rights, to show their location and capacity."

"There is not now, and never has been, any means by which a prior appropriator could protect himself from the encroachments of a later user, except by a resort to the courts. There is now no way in which a bona fide user of water can have his right thereto established or enforced, except through a law suit."

"On many streams the rights which are recognized as vested are fixed entirely by custom and usage. They have not behind them the sanction or authority of any tribunal qualified to give or confirm a title, yet their holders and other appropriators from the same stream recognize their validity and regard them as belonging as completely to their holders as the products of the fields which their use secures."

"It is a peculiar system. The State does not claim any ownership or property rights in these streams, hence the titles to water do not come from the commonwealth. It is the ditch owners and water users themselves who claim and exercise the right to control and divide up among themselves the river which rises on land they do not own; which is fed by snows on the mountains they do not control, and which comes from clouds that are as much public property as the air itself."

"The absence, during the territorial period, of statutory forms of procedure in establishing rights of water, or of any definite unit of measurement in describing them, has led to their taking curious and diversified forms. Some rights are based on the acres irrigated; others on the fraction of the stream owned; others on the size of the ditch. All of these mean something definite to the owner of the right, but not to everybody. It is much like trying to describe real estate by basing its measurement in some cases on the length of a rope; in others on the length of a chain;

and in others, on the distance the surveyor could jump." * * *

"These facts are not presented as a criticism of what has been done, but to call attention to conditions too serious to be ignored, and because some reform ought to be had. No higher service can be rendered the irrigators of Utah than to forcibly and repeatedly remind them of the necessity of an early enactment of an adequate irrigation code." * * *

RECORDS OF VESTED RIGHTS.

"The territorial laws and court decisions gave a satisfactory basis on which to build up a working code of laws, but the necessary administrative machinery has never been provided. An attempt will be made to explain what is, and has been, lacking, beginning first with the need of an official record of existing rights."

"Every user of water needs to know both the exact priority and amount of his own right and that of all others which divide with him the possession of the common supply. The first thing looked for in the study of Utah's irrigation system was the record of existing rights. The reply to the inquiry as to where they could be found was: "There are no records; every irrigator in Utah carries his title to water around in his hat." This somewhat irreverent statement is very near the truth. Probably not one-half the vested rights are of record anywhere, or in any form, and those recorded are in such form as to give little knowledge of the existing situation." * * *

"There is no single office of record for these rights. The records of the county recorder contain the "claims to water" and the adjudications of the ex-officio board of water commissioners and such sales and exchanges as the parties thereto have seen fit to record anywhere."

"The decrees of the courts, which may entirely change the ownership set up in the recorder's office, are to be found in the clerk's office."

"As the court decisions are in settlement of controversies between individual appropriators and are indexed in the names of the litigants, it is almost impossible for those not familar with the stream to find these decisions."

"The claims to water in each county are recorded in that county alone, but many of the streams which they affect cross county boundaries. The Jordan river, with its feeders, embraces four counties, so that to examine the claims to a single supply may involve much travel and expenditure of money and time, all of which is needless under adequate laws."

"The uncertainties of the original records are only a beginning of the complications which surround water titles in this state. Many adjudications were made under the Act of 1880, and a large number of certificates issued. When this law was declared invalid the legality of the titles thus established, under its provisions, became questionable, but they are still on record; in some instances they govern the use of water, in others not." * * *

"The office of State Engineer was created in 1897. There is great need of the supervision which this office can exercise, and if given sufficient authority and opportunity, he can become the most important and valuable official in the state so far as the prosperity of farmers is concerned. This cannot result under the law as it now stands. This office should be the place of record of all titles; it is not of any. He should begin at once the measurement of all streams; he has no funds for the work. He should be the administrative agent for the enforcement of adjudicated rights; he has no authority whatever to protect vested rights. Except in the examination and approval of plans for dams, he has no administrative authority whatever. His powers in other directions are wholly advisory. This is not what is needed in dealing with the chaotic situation which confronts the holders of vested rights. The creation of the office, like many other features of the laws last enacted, are all steps in the right direction, and places Utah among the progressive, as it is among the most important arid commonwealths."

RECOMMENDATIONS.

In compliance with the requirements of Section 2458, I desire to make the following recommendations regarding changes in water laws:

1st. That the State Engineer's office be made the office of record of all claims to water.

2nd. That all persons desiring to appropriate water, before beginning its diversion, be required to secure a permit for the same from the State Engineer.

3rd. That all county records of all claims to appropriations of water be transferred to the office of the State Engineer, who shall classify and file the same.

4th. That the State of Utah be divided into four or five water divisions, provision being made for the appointment of one superintendent for each division, who shall report to the State Engineer. Division superintendents to have authority to make regulations to secure the proper distribution of water, reserving the right of appeal from the regulations of the superintendents to the State Engineer. The present system of watermasters to be continued, with the provision that they be required to report to the division superintendents.

5th. That the State Engineer and division superintendents be constituted a board of control, to adjudicate the rights of all the public waters of the State, reserving the right of appeal from the decisions of the board of control to the courts.

6th. That provision be made for the State Engineer to make an examination of any stream to be adjudicated, such examination to include measurements of discharge of stream, surveys of canals and ditches diverting water therefrom, measurements of lands irrigated by the canals and ditches, and any other information that may be of assistance in the adjudication.

7th. That provision be made for the apportioning of stored water under the direction of the State Engineer.

8th. That, in brief, the water laws of Wyoming be adopted, with such changes and modifications as may best suit the conditions in Utah, repealing all the conflicting laws now on the statutes of Utah.

In this connection, I desire to quote from Kinney on Irrigation Law, as follows:

KINNEY ON IRRIGATION—PARAGRAPHS 492 AND 493.

"492. Statute of 'State Control' and 'District Law' compared. This law, providing for the State control and use of the waters of the State of Wyoming, is the most elaborate and effective statute of the class of any of the States or Territories of the arid region. In contrast to the district law of California, as adapted to the thickly settled States, the present law of Wyoming may be considered the best and most effective law upon the subject of water-rights governing the sparsely settled portions of the arid West. Although we regard the 'District Law' as the true economic principle in the control and application of water for irrigation, we do not think that the condition of the sparsely settled States like Wyoming is ready for such a law. In California, when the district law was adopted, the conditions in many parts of the State where the districts were actually organized were such as to make the handling of waters for irrigation almost as clearly a matter for municipal control as the handling of water for domestic use in cities, or the paving of streets or the laying of sidewalks. Of what utility is the district law in the sparsely settled sections of the country where the solitude is yet to be broken by the sounds of civilization, and where money and labor must first perform great tasks before there can be a population sufficient to vote bonds or fill the offices of the district, and where all the natural conditions of the country are entirely different from those in California, where the 'Wright Law' has been so successful?

"493. This last legislation gives a final and speedy solution of many of the troubles that, before its passage, beset the irrigator in the State of Wyoming, and its practical operations are being watched by the people throughout the arid region, as it seems to promise so much to them. In preparing this law advantage was taken of the experience of other States, and much that is best has been incorporated from the laws of other irrigating countries. The law is unique in this, that the State does not necessarily wait for controversies and losses to arise, but of its own motion steps in and ascertains how much water is available for irrigation; who are the claimants to this water; and then, knowing these fundamental facts, gives the use of the water to the proper persons, employs its own agents to see that the distribution is made. In Wyoming, at least, there will no longer be the ludicrous spectacle of learned judges solemnly decreeing the right to from two to ten times the amount of water flowing in the stream, or, in fact, amounts so great that the channel of the stream could not possibly carry them, thus leaving the questions at stake as unsettled as before."

"From a study of the law it is very apparent that the State Engineer and Board of Control hold the most important offices in that State so far as its agricultural interests are concerned, and by a wise and skilful exercise of the functions intrusted to them, can bring about great changes for the better in the development of the agricultural resources of the State. The State Engineer is president of the Board of Control. Objections may be made by some that there is too great a centralization of power in one man. But this is answered by the provision for appeal to the courts by any party feeling himself aggrieved and by the provision that when the case is finally decided the right of the prevailing parties relates back to the first step taken by him to secure his water rights. Thus his rights are not jeopardized by the delays often attendant upon court proceedings. The law provides that the priority of the claimant's right shall be the basis for the determination of his right to the use of water. The law also provides for the adjudication of his claim, which, when made, entitles the claimant to a certificate of appropriation to water, stating the amount of water he is entitled to, the land it is intended to irrigate and the number of its priority. And now for the first time he has a deed to the water, which is even more important and valuable than the deed to his land, from the fact that his land would be absolutely worthless without the water. It will thus be seen that, while five years ago Wyoming had practically no water law, it stands today pre-eminently at the head of the list respecting irrigation legislation adopted by the various states and territories of the arid region, as applying to the sparsely settled communities of that region. It has embodied in its law all that has been found good and efficient in the operation of the laws of other states and territories, with the exception of the 'District Law' of which California has the model."

CONCLUSION.

In conclusion, I beg to urge the necessity of impressing upon the members of the Legislature the importance of relieving the chaotic condition of affairs by proper legislation. The original appropriators of water in this state are passing away. As their testimony is of the greatest value in obtaining a correct adjudication of streams, it should be placed upon record at the earliest possible date. The sooner this is done, the better; the longer it is put off, the more costly and difficult it will be to obtain the information necessary for equitable adjudications. If the water laws of Utah are allowed to remain in their present shape, it is safe to say that many times the amount of money required to adjudicate *every water right* in the state will be spent in *law suits* during the next twenty-five years.

The writer is well aware that these matters have been regularly brought to the attention of past Legislatures, and that the members, as regularly, have failed to see the importance of the enactment of such laws as would do away with the difficulties described. He feels, however, that it is his duty to give warning of the heritage of litigation that will surely be bequeathed to the next generation, if the present conditions are allowed to continue indefinitely.

EXHIBIT "A."

STATE ENGINEER'S OFFICE,
SALT LAKE CITY, UTAH.

INSTRUCTIONS TO BE OBSERVED IN PREPARING PLANS OF DAMS OR DIKES.

To All Concerned:

The following instructions are issued for the purpose of assisting the people of the State to properly comply with the provisions of Section 2453, Revised Statutes of Utah, 1898, which reads:

2453. To examine plans of dams or dikes. Powers. Any person, association or corporation that shall desire to construct any dam or dike, for the purpose of storing or appropriating or diverting any of the waters of this state, when the same is to be more than ten feet in height, except as otherwise in this chapter provided, shall submit duplicate plans, drawings, and specifications of the proposed work to the State Engineer, who shall, as speedily as possible, and within forty-five days, examine such plans, drawings and specifications, and if he approves them, he shall affix his approval thereto, and return one copy of each such plan, drawing, or specification, with his approval, to the party or parties proposing to construct the works. If the State Engineer disapproves of such plans, drawings, or specifications, he shall return the same with his written objections thereto and suggestions of changes to the party or parties filing the same; provided, that where said dam or dike is, in the opinion of said engineer, not of sufficient importance to have the provisions of this section apply to such dam or dike, then said engineer shall have power upon written application to suspend the provisions of this section to such dam or dike. In case of works of great importance, especially, where life or property would be endangered by the failure of such works, the State Engineer may require excavations to be made to determine the character of the foundation and require a statement of the facts in the case to be filed in his office before approving such plans, drawings, or specifications; or he may if he deems the public interest demands, visit the locality of such proposed works before approval of said plans, drawings, or specifications; and no rights of any kind under the laws of this State shall be deemed to be obtained which have not been approved by the State Engineer. ['97, p. 78.

INSTRUCTIONS:

1. All plans and specifications must be prepared by a competent civil engineer; surveys and maps may be made by any competent surveyor.

2. Drawings and specifications in duplicate must be submitted for approval, one set to be permanently filed in the office of the State Engineer, and the other, when approved, to be returned to the party or parties proposing to construct the works.

3. Map shall show the location of reservoir, wasteway and outlet; land that will be flooded when reservoir is full; area of reservoir in acres, and extreme and average depth of water in feet.

4. Plans shall include both longitudinal and cross sections of dam, wasteway and outlet. They shall show the material of which dam is to be constructed; its length on top and length on bottom; its width on top and bottom, with slopes of both front and back; its height above water line when reservoir is full; the width and inclination of wasteway and depth below top of dam.

5. Specifications shall explain fully the natural conditions pertaining to the dam and reservoir sites, and shall state in detail just how the dam is to be built. They shall be of such a character as to enable the work to be constructed therefrom.

6. All plans and maps must be drawn with India ink on tracing cloth cut to one of the following stand-

ard sizes, viz: 28 inches by 40 inches, or 20 inches by 28 inches.

7. A plain black border must be drawn around the sheet one inch from its edges. Sufficient space must be left inside of the border for notes of approval.

8. The lettering and figures for titles, notes, numbers, etc., and all dimensions, must be neatly printed in some plain style of lettering, such as:

OLD STYLE EXTENDED.

VICTORIA ITALIC.

GOTHIC.

INCLINED GOTHIC.

Caledonian Italic, or ***Gothic Italic.***

ROBERT C. GEMMELL,
State Engineer.

EXHIBIT "B."

STATE ENGINEER'S OFFICE,
Salt Lake City, Utah.

Special Instructions to Watermasters

AS TO

Measurements of Water

SO AS TO SECURE A

JUST DISTRIBUTION OF THE SAME.

December, 1900.

PREFACE.

The work on this pamphlet was commenced by the former State Engineer, Willard Young, now Col. of the 2d. Reg. of U. S. Vol. Engrs., and was completed by the writer. This is more fully explained on page 28.

In preparing Tables III and IV, the authors were well aware that they were exceeding the limits of the formula as set by Mr. Francis, that is, the use of heads from 6 to 24 inches; but it was believed that the results would be sufficiently near the truth for practical purposes. Watermasters in Utah are rarely engineers, and it was therefore thought best to prepare Table IV in such a manner that the discharges could be read without any calculations whatever. The tables were computed by using feet and decimals of a foot for the heads, H. For the benefit of watermasters, who as a rule have no means of measuring the head in decimals of a foot, the heads are also given in inches and fractions of an inch. The pamphlet was prepared primarily for the use of watermasters, but it is hoped that the tables may be of use to engineers also.

ROBERT C. GEMMELL,
State Engineer.

Salt Lake City, December, 1898.

CONTENTS.

STATE ENGINEER'S OFFICE,
Salt Lake City, Utah, December, 1898.

To all Watermasters in the State of Utah:

The following Special Instructions as to Measurements of Water, so as to secure a Just Distribution of the same, are published in compliance with the provisions of Section 2457, Revised Statutes of Utah, 1898, which reads:

"The State Engineer shall, free of charge, give any information desired by any person as to the proper method of measuring water or of constructing an apparatus for such measurement, upon proper application being made; and shall give special instructions to all watermasters as to measurements of water, so as to secure a just distribution of the same."

The Legislature has here directed the State Engineer to perform an official duty, the purpose being to secure a just distribution of the waters of the State amongst the various corporations, companies and individuals entitled thereto. It is confidently believed that a careful observance, on your part, of the following instructions will, as nearly as possible under the existing conditions, accomplish the purpose sought, and will prevent much ill feeling and costly litigation. If, however, you do not lend your earnest and hearty support in carrying out the instructions, but try to evade doing what is asked, the desired results cannot be obtained.

SPECIAL INSTRUCTIONS TO WATERMASTERS

AS TO

MEASUREMENTS OF WATER.

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1. Hereafter every corporation, company or individual who diverts or takes out the whole or any part of the waters of any public stream for any useful or beneficial purpose shall cause the same to be properly measured, at least once a week, during the time the water is being diverted, and shall cause a careful and accurate record of each such measurement to be made and preserved. Copies of the records of all such measurements shall be furnished annually, and not later than December 1st, to the State Engineer, for file in his office.

2. In all cases, where practicable, such measurements of flow must be made by means of sharp-crested rectangular weirs, with free fall, and with full contraction, or with no contraction, and with the velocity of approach less than six inches per second. Where this method is not practicable, special instructions will be given by the State Engineer as to the best available method for making the required measurements in each particular case.*

3. For the sake of uniformity, all computations of discharge over rectangular weirs shall be made by the formula:

$$\text{Discharge} = 3.33\left(\text{length} - \frac{\text{number of end}}{\text{contractions}} \times \frac{\text{head H}}{10}\right) \times H^{\frac{3}{2}},$$ in which the discharge will be given in cubic feet per second. The length and head are both in feet and decimals of a foot. If the velocity of approach cannot be kept below six inches per second, a correction must be made therefor.†

4. Wherever the water flowing in any canal or ditch is to be divided in varying proportions by means of lateral ditches taken out at different points, the division shall be made by measuring the flow in cubic feet per second, by means of rectangular weirs in each lateral, and taking the total of these measurements as the total available flow in the main canal or ditch, and then apportioning the water amongst the several laterals accordingly.‡

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*The adopting of an uniform method of measurement, such as here recommended, for use throughout the State will have this advantage: that any small errors incident to the method will be of minor importance, inasmuch as all errors will be distributed proportionately, or very nearly so, amongst the various ditches where the water is measured.

†See "Velocity of Approach," page No. 18.

‡There is always some loss by seepage and evaporation between the head of a canal and the points where the lateral ditches are taken out. Such loss will be borne proportionately by adopting the method here recommended, and the question of loss by seepage and evaporation, so far as a fair division amongst the lateral ditches is concerned, will be entirely eliminated.

5. **Where, as in the case of small ditches or laterals owned or used in common, it is desired to give to the several parties interested some definite proportion of the water flowing in the ditch without measuring the flow in cubic feet per second, the division shall be made in the following manner:** The water in the ditch shall be brought to a complete state of rest, or very nearly so, and then be allowed to flow, with free fall, over a rectangular weir without lateral contraction, or over a Cippoletti trapezoidal weir, the crest of the weir in either case to be truly horizontal. One or more partition boards, with thin edges, will be placed at right angles to the weir and directly below it, to divide the falling waters. The division thus made will be taken to be in direct proportion to the distances intercepted on the crest of the weir. If the ditch or stream is of considerable size, so that the proper proportion between depth and length can be maintained, the depth being at least four inches, the division may be made by separate weirs whose lengths are in direct proportion to the division to be made. Rectangular weirs without end contractions or the Cippoletti trapezoidal weir must be used, and great care must be exercised to see that the crests are truly horizontal and at exactly the same level, one with the other.

6. In cases where several parties are interested in a small ditch or lateral, in which the amount of water is only sufficient for one user at a time, the division shall be made by the time method.*

WILLARD YOUNG,

STATE ENGINEER.

*See "Division of Time Method," page No. 7.

MEASUREMENT AND DIVISION OF WATER.

WHAT IS SAID REGARDING THE WEIR METHOD OF MEASUREMENT.

"The most accurate mode of measuring the flow through small open channels is by means of weirs." Page 332, Theory and Practice of Surveying.—*Johnson.*

"The method of measuring discharge which is most popular among irrigators of the West because of its simplicity is by means of weirs. This method is best suited to streams and canals of moderate size, while the results are quite accurate. It is exclusively used in Australia, and extensively employed in Colorado and other portions of the West. Among the advantages of the weir as a measuring device are its simple construction, accuracy, cheapness and ease of operation. Its results are easily interpreted by use of tables; it gives quantities of flow in second-feet feet directly; it is not necessary to maintain a constant head above it; and it causes a trifling loss of head.

Where the contraction is complete its coefficient remains constant, and the Francis formula gives the discharge with errors not exceeding one half of one per cent for depths of water varying between 3 and 24 inches, providing the length of the weir is not less than three or four times the depth of the water flowing over it. * * * The measuring weir is in all probability the most satisfactory method of obtaining an accurate measure of the volume of water passing through a canal." Pages 74, 75 and 84, Manual of Irrigation Engineering.—*Wilson.*

"There are four methods of gauging the flow of a stream: (a) by weirs; (b) by floats; (c) by formula; (d) by meters. Weirs are practicable and economical only in case of small streams at low water, and in such cases the system is preferable to all others." Page 80, Irrigation Survey, First Annual Report—*Dutton.*

"In studying the duty of water it is necessary that the measurements of small quantities be made with a greater degree of exactness than is possible with a current meter. A small weir can usually be placed in an irrigating ditch, at slight expense, providing there is sufficient fall, and if correctly proportioned and the well known Francis formula be used, will give the flow with great precision. The use of the knife-edged weir is rapidly extending in the West, the accuracy of the measurements offsetting the inconvenience or care required." Page 5, Irrigation Survey, Second Annual Report. —*Powell.*

"The weir affords a very convenient means for gauging the flow of small streams."—Page 265 Trautwine's Engineer's Pocket-Book.

"No device for measuring flowing water has been more thoroughly tested and experimented with than the weir, with the result that notwithstanding the simplicity of its construction, we may, by taking proper precautions, determine the amount of water flowing over it within one per cent." Page 156 Bulletin No. 6, Montana Agricultural Experiment Station.—*Ryan.*

"It is indisputably demonstrated that in weirs with complete contraction, constructed and observed with the necessary accuracy, the coefficient of contraction remains constant, and Francis' formula guarantees the exactness of discharge with an error not greater than one half of one per cent, for depths of water from 3 to 24 inches; providing the length of the weir is not less than three—or better yet, four—times the depth of water flowing over it." Page 135 Canale Villoresi.—*Cippoletti.*

"But of all forms of modules, or that which best satisfies the first condition of accuracy, is the form of opening known as the weir, or overfall. It is not intrinsically more accurate than many other forms of opening, but as it is so simple that the conditions for accuracy may be readily met, and because there is a vast fund of experimental knowledge regarding its behavior under different conditions, no other form of opening can compare with it in accuracy.

"Because of these facts and the growing importance of accuracy, the coming module will be based upon the weir. It is gradually displacing other types. Australia is using it exclusively, we think; India, to a large extent, and in Italy, the originator of most of our measures, the newer canals are using it to the exclusion of the Milanese module. * * * A large portion of the newer canals in Colorado provide that measurement shall be made over a weir. So far as learned, no canal has abandoned its use." Page 23, Bulletin No. 27 of the Colorado State Agricultural College.—*Carpenter.*

"The theory of flow over rectangular weirs with horizontal crests and vertical ends is more accurately established by numerous experimental and positive measurements, than for any other form of notch." Page 278, Treatise on Hydraulics and Water Supply Engineering.—*Fanning.*

EXTRACTS FROM BULLETIN NO. 27, STATE AGRICULTURAL COLLEGE, FORT COLLINS, COLO., ON THE MEASUREMENT AND DIVISION OF WATER, BY PERMISSION OF ITS AUTHOR, PROF. L. G. CARPENTER.

Questions concerning the measurement and distribution of water probably give rise to more trouble than all others combined in an irrigated country. While frequently the matter in dispute is of small consequence, it is a source of irritation that causes constant annoyance both between canals and consumers, and between neighbors. The problem of a just distribution of water is one of the most important as well as one the most difficult problems of irrigation. * * *

In general it may be said that the prevailing methods are exceedingly unreliable. In some canals, even the large ones, there is little attempt save by the eye or the judgment of the ditch rider; in others there are nominal measures which frequently are worse than none at all, because while giving no approach to a proper measurement, they give among the consumers and canal officers a false sense of accuracy and stand in the way of a better system. In others the systems are as good as the present conditions will permit. When water has been plentiful in the streams, there has been no necessity for close division or measurement, for there has been water enough to supply the demands of all. But with the greater demand for water and the need by each farmer of every drop obtainable, there is greater necessity for closer measurement, and many canal organizations are being led to consider more efficient means of measurement and distribution.

The prevention of waste is a matter of public importance. With more land than water, the agricultural future depends on the use of the existing water supply to its fullest capacity. The building of storage reservoirs, the stopping of waste, improved methods in irrigation, together with the changes consequent on irrigation, which make less water necessary, will increase our water supply in effect, if not in amount.

It is safe to say that a good system of measurement will save a large amount of water. Every one knows that in financial affairs a close account is the basis of sound economy. It is also true in water matters. The mere fact of measurement makes users more careful about waste, and in the aggregate the saving is considerable, as some cities which measure water to consumers have found. With water plenty, the system, or lack of system, works without friction. The practice is to give enough to stop complaint, if there is water enough. But as water becomes scarcer and the demand greater, then the system works gross injustice. If some one gets more than his share, it means that some one else gets less. And this may mean ruin to his crops. In many parts of the State the pressure for water is already being felt. It is only a question of time when the other localities will feel the same pressure, and with time all will feel the demand more. Hence it is that there will never be an easier time for arranging satisfactory measurement than now; for the demand will not be less, and with time and the increase in value of water then there will be many who will feel that they have rights vested in certain methods of measurement which may be intrinsically unjust. * * *

In the measurement of water there are two distinct classes of measurement boxes, different in their object. One is the dividing box, whose object is to give to each consumer some definite portion of the water flowing in the ditch. This box is found especially in the laterals owned in common by two or three neighbors, or in the smaller canals owned and operated by the stockholders. The other class is the measuring box which has in general for an object to give the consumer a certain definite quantity of water, as one cubic foot per second. These need to be adjustable, so that in times of scarcity the amount may be reduced proportionately as the quantity in the canal decreases. To this last class the Italians give the name of *modulo.* The French writers on irrigation, and to a limited extent the English, have adopted the word in the form of *module*, and as such a word is needed in our irrigation vocabulary, the term is here used. *Module* will therefore be used to designate those boxes or devices, whatever their form, whose object it is to measure the quantity of water delivered, or to give a constant flow. The word *divisor* will be restricted to the first class, whose only object is to divide the water. A module may evidently serve as a divisor, for if the amount to be divided is known it is a simple matter to determine the quantity to which each is entitled and to regulate the module accordingly. There will always be cases where divisors will be by all means the most convenient, but these cases will be mostly in the small ditches from which few take water. In all other cases modules of one kind or another will be found the better.

In the case of divisors it is evident that there is no unit of measure, and that none is needed, as the object is to give the consumer some definite portion of the water flowing in the ditch whether there be much or little.

In the module, on the contrary, some unit is needed.

It is unfortunate that a system has grown up in which the professed unit is the "inch." The word is used in such a multitude of meanings that it is an almost hopeless task to convey an exact idea of quantity by the word. It in effect takes into account only the cross-section of the channel or opening, without regard to the velocity of the water. In the same ditch it is attempted to have the velocity the same or nearly the same through the different openings, by keeping the head the same, but in different ditches the heads vary according to convenience or the notions of the original users. In some ditches the head is four inches, in others six, in some eight, and there are others which allow the opening to extend to the surface of the water and no pressure is used. The whole area of the opening in square inches is then counted as inches of water. Also, in common use, a practice has grown up to call the cross-section of the stream in square inches, without regard to the velocity of the water, as so many "inches." Manifestly there is nothing in common in these different inches, so that the term has no definite meaning. * * *

The cubic foot per second is an absolute unit whose quantily cannot be subject to dispute, though the accuracy of measure may be. The State laws provide that in appropriating water to ditches the quantity shall be estimated in cubic feet per second, or as frequently shorter expressed, as second feet.

DIVISORS.

As ordinarily constructed the division can rarely be exact, but, frequently, the convenience of anapproximate division more than counter balances any inaccuracies there may be. The larger ditches rarely have occasion to use divisors; for, even if the ditch has to pro rate the water, a better distribution can be effected by means of modules. If the water is to be divided into two equal portions, by placing the two lateral ditches in identical relations to the main ditch, in a straight and uniform channel, the division is exact. Emphasis should be laid on the *identical* relation, for many divisions are seen where the conditions are not the same, as, *e. g.*, one branch continues straight, the other may make an abrupt turn, one may pass through a covered box, etc. In these cases some advantage is given to the ditch having the freer discharge. The effect of these differences is greater than is generally supposed. It is, however, generally easy to meet these conditions if the parties desire. In the same way the water may be subdivided into four, eight or sixteen equal parts. But where it is required to divide the water into two unequal, or into three or more portions, equal or not, the division becomes one of approximation only. The difficulty arises from the fact that the water has not uniform velocity across the whole channel, the center has greater velocity than that nearer the banks. If therefore, equal openings be made across the channel, those near the center have the greater discharge. Making the central openings smaller, only partially evades the difficulty; for as the relative velocities of the center and sides differ with different depths, this arrangement would still be inexact for any one depth except that for which the opening is made.

In its most common form the divisor consists of a partition dividing the channel into two portions in proportion to the respective claims. This, in effect, assumes that the velocity is uniform across the whole cross-section, which is not the case, even in a uniform channel, and much less so in one irregular or in poor repair. Such a division is to the disadvantage of the smaller consumer.

The nearer the velocity is uniform across the whole channel, the better this method of division, evidently. Accordingly means are frequently taken, by weir boards or otherwise, with this object in view, but generally with indifferent success. * * *

If water is brought to a complete state of rest, or very nearly so, and flows over the weir without lateral contraction, this method will give as satisfactory results as any divisor with which I am acquainted. An increase in the size of the ditch just at the division box will aid in bringing the water to rest. * * *

DISTRIBUTION BY TIME.

On small ditches or laterals where the amount of water is not too great for one user to manage, the time method of division may be used and gives a more equitable division than the boxes of the types described, and besides it accomplishes what is necessary in order to use water economically, it allows of the use of water in large enough quantities during irrigation to make the use much more economical than where used in minute quantities. If water is divided according to the various interests involved, so that each would receive constantly the amount to which he is entitled, and no more, it would often happen that the division would be into such small parts that little good would be done by the small stream of water thus furnished. It thus becomes necessary in almost all localities to exchange water between neighboring users, so that one will use the privileges of several for the time during which he is irrigating, and then the others in like manner will use the water of their neighbor whom they have already accommodated. The time method of division carries this exchange of water to a greater extent and is especially applicable to the small ditches where the amount of water is small. In such case the exchange is systematized, and each one takes the whole stream of water for a time proportionate to his interests in the ditch, and the period is so arranged that the rotation will be complete in some definite time, as a week, or two weeks, or such other time as the experience of the locality has shown to be desirable for an irrigation to be repeated. The water will then be given out at night or day according to schedule, and in order that the inconveniences may be fairly distributed, the period of rotation may be made with a fractional day, so that those who came in the night during the first rotation will come in the day during the second, and vice versa. Thus, suppose the period of rotation be taken as one week, or for reasons above given, 7½ days, and the number of shares be fifteen, of which some own one, others two, and some three shares. In this case each share would give its owner the right to use the water for one half day, or twelve hours; the owner of two shares would be entitled to its use for twenty-four hours, and the owner of three shares to thirty-six hours. Where there are a large number of rights or users the same method would be carried out but to a greater extent. As carried out in the countries where it is applied, the division may be carried out until the exact number of minutes to which each is entitled to the water is determined. In such case a small table needs to be prepared in advance, usually at the beginning of the season. Each one is furnished with a copy of it, as well as the ditch superintendent and employees, and the water is shut oft or turned on the different gates according to schedule. The user must be ready to take it at the proper time or lose the water until his turn at the next rotation.

This method is best applicable evidently in the cases where the amount of water flowing into the lateral is constant. This, under the present conditions of American practice, is rarely the case. The water in the main ditch and consequently in the smaller laterals, is subject to the fluctuations of the main stream. Where water is distributed from reservoirs, then the flow may be maintained uniform. The necessity for restriction in the use of water to certain assigned times is also distasteful to many. But by common consent methods are used which are leading to the same system, and with the gradual increasing pressure for the greatest benefit from the amount of water available, there is little doubt that this method will gradually extend in use under the conditions where it is best adapted. With the varying streams and varying flow, with the previously prepared time table, the method is not so equitable as the division of water as it comes. But with the advance of canal administration and with increase in knowledge of the flow of water, it will be possible to adopt a modified time-system of distribution which will be adapted to the varying streams. It is already in ditch administration in Colorado becoming customary to keep records of the amount af water which is taken into the canals. It will become increasingly desirable, and even necessary. For the large ditches taking water from the streams, the amount of water which is taken into the ditch for different depths of water in the ditch is officially determined by the State Engineer or his deputies. A similar rating of the lateral ditches may be made or weirs may be used with greater accuracy. As it becomes possible to find men who can use the various methods of measurement to determine the amount of water flowing, it will be possible to use a modified time distribution, so that each will be given the water long enough to give each the same quantity. This would give a short time for the periods when the water is plentiful, and longer times when low. The unit could be varied, so as to bring the irrigations a convenient time apart. The successful operation of such a system would require an intelligent superintendent, and one who had the confidence of the users of the water, or a widespread knowledge among the users.

In the distribution of water from small reservoirs, where there are but few interested, and where the different owners do not care to use the water at the same time, some such arrangement is necessary. With the weir measurement it is possible to keep account of the amount used by each person, so that the water may be divided in proportion to the rights of each.

MODULES.

It is not possible to secure a module satisfactory in every respect or to meet all conditions. Where there is fall to spare in the ditch some forms are available which would be excluded if there were no fall to spare.

The features desired in a module may vary under different conditions, so that there are some forms which give excellent satisfaction in some circumstances, which do not in other cases where the conditions emphasize the desirability of some other feature. In the early stage of water measurement, when water is abundant, accuracy is a minor consideration; while with increased demand for water, it is one of the first, if not the first consideration. A second desirable feature, which has been the object toward which many have worked, is a module which is self-regulating and preserves the same discharge of water even with fluctuating depths of water in the canal.

The following may be considered desirable conditions in a module. Most of these conditions were recognized several centuries ago by the magistrates of Milan:

*1. Its discharge should be capable of being converted into absolute measure—as into cubic feet per second.

*2. The ratio indicated by the module between the discharges from two outlets should be the same as the actual ratio.

*3. The same module or box should give the same amount of water wherever placed.

4. It should be capable of being used with large or small canals.

*5. It should be capable of being set to discharge any fraction of its capacity, so as to be capable of distributing water pro rata.

6. Surreptitious attempts to alter its discharge should leave traces easy to recognize.

7. It should be simple enough to be operated by ordinarily intelligent men.

8. Calculation ought not to be required in order to regulate the discharge of different modules, or to determine how much they are discharging.

9. It should occupy but small space.

10. The discharge should not be affected by variations in the level of water in the supplying canal, or, in other words, it should be self-regulating.

*11. Its cost should be small, and it ought not to require much fall.

These conditions are evidently not of equal importance. The most of the conditions have been recognized for several centuries. Those unmarked are essentially the same as those given some centuries ago.

Condition 1, on which depends the accuracy of the measure, becomes day by day increasingly important, and is the one which with the passage of time may be considered the most important. If the first condition is met, Nos. 2, 3, and 4 which are practically included in it, are also met.

The question of expense, mentioned in No. 11, is a relative one, and may or may not be of importance. It becomes of less importance as the development of the irrigated section becomes greater and the needs for accuracy become more generally felt. But the requirement that the fall required shall be small, is a physical condition which it is often absolutely necessary that modules for special locations must meet.

Condition 8 becomes of less importance, with the increase in intelligence of those whose duty it is to distribute water, and is not objectionable against such modules as the weir, where tables of discharge may be prepared which enables the discharge to be determined without computation by the user.

No. 10 is the condition which to the early users is almost always the most important. The reason has been partly one of the stage of hydraulic science, in which it has not been known how to measure the quantity of water passing except by passing the water through orifices. In order to make the velocities through these orifices the same, it has been necessary to make the head of the water equal in these different places, and consequently to secure a measure it has been desirable to keep the heads over the openings constant. The condition is less important with us, both because with the growth of hydraulic science the amount of water may be measured with more accuracy than the early users knew how, and because our conditions are different. In our practice it is rarely attempted to make the discharges constant. Instead as the canals usually have largely different quantities of water during the season, it is far more important that the water shall be cut down in each smaller ditch in the same ratio. * * *

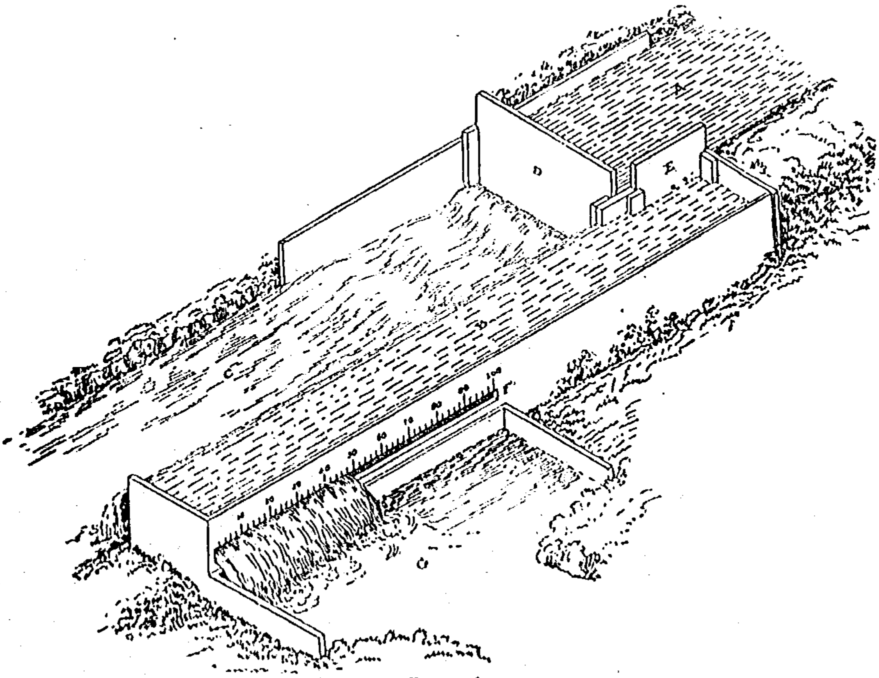

FIGURE 1.

SPILL-BOX.

Another means of preserving a constant head is due to A. D. Foote, of Idaho, Past President of the American Society of Irrigating Engineers.

A cut of this was given in the *Engineering News*, of November, 1886, and it has been more fully described in the transactions of the Am. Society of Civil Engineers, Vol. XVI.

In Fig. 1, A is the main ditch, with a gate forcing a portion of the water through box B. This has a board on the side towards the main ditch, with its upper edge at such a heighth as to give the required pressure at the orifice. Then if the water be forced through B, the amount in excess of this pressure will spill back into the ditch. If the box B is made long enough, and the spill-board be sharp edged, nearly all the excess will spill back into the ditch, thus leaving a constant head at the orifice. Mr. Foote calls this the excess weir. He constructed one for trial purpose. To Mr. W. H. Graves, of Monte Vista, is due the credit of its introduction into use on large canals, with the necessary modifications. He terms it the spill-box, a more suggestive name than that proposed by Mr. Foote. In

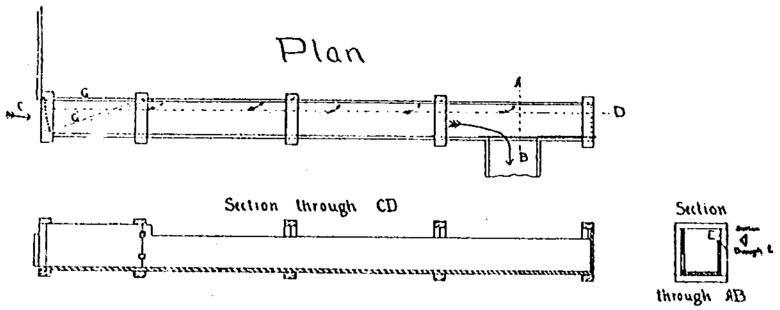

FIGURE 2—PLANS OF THE SPILL-BOX.

C is the entrance of water from the ditch; G a gate which serves to admit as much water as is desired B the outlet furnishing water to the user. The small arrows show where the water spills back into the main ditch.

use, Mr. Graves constructs a weir in the canal, and places the box at one side, always using two, if possible, one at each side, to save fall and expense. The spill-box is about 16 feet long, 14 inches wide, set perfectly level. The crest next the canal is brought to a sharp edge, and so are the 2x4 pieces on that side of the box. The gate for opening the orifice is of galvanized iron, worked by a rod and wing nut from the end of the box, so that it may be adjusted to any desired size of opening, and locked. The side of the opening is protected by strips of galvanized iron, with the double purpose of protecting the orifice from surreptitious enlargement and furnishing a groove for the gate to slide in. Mr. Foote thinks that the main ditch need not lose more than a few inches fall—enough to have the excess spill back. Mr. Graves prefers at least a foot.

The success of the device for maintaining the head constant is very good though it cannot be said to be perfect. It may be made much more sensitive. Under normal conditions the variations in head will be confined within small limits. As the spill-box is especially a device for keeping the head constant it may be used either with the weir or with the inch system, or with any form of opening.

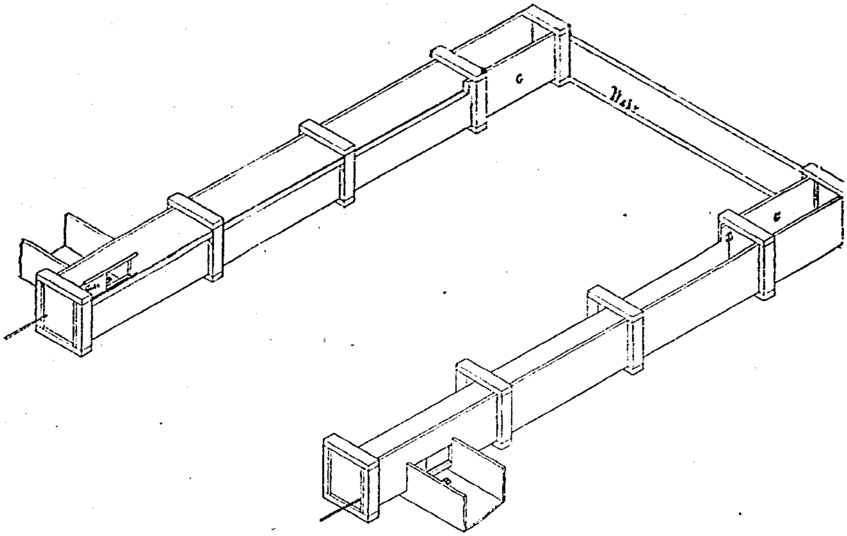

FIGURE 3.—THE SPILL-BOX.

(As usually placed in pairs.)

The weir is placed across the ditch, making the ditch lower below than above, giving opportunity for the water to spill back iuto the ditch. G is a movable gate to regulate the amount of water admitted at different stages of water in the canal.

By making the box longer, so as to increase the length of the edge over which the water spills the device may be made more sensitive. * * * In some places is adopted a form where the box is placed so that it spills on both sides, and the sharp edge is made on both sides of the box.

THE WEIR MODULES.

A measuring weir is always arranged with its back or up-stream side, A B Fig. 4, vertical, and as nearly as may be at right angles to the direction of flow of the stream. The ends A H, A H Fig. 5, 6, are vertical, and the crest A A is horizontal. When the weir A A extends entirely across the channel of approach, as in Fig. 5, so that the ends A H, A H, coincide with, or form portions of, the sides S S of the channel, contraction takes place only at the *top* and *bottom* of the sheet of water passing over the weir, as at M C and at A, Fig. 4, and is entirely suppressed at the *ends*, so that the water flows out as shown in Fig. 7. Such a weir is called a *weir without end contractions*. But when, as in Fig. 6 and 8, the ends A H, A H, are at a distance from the sides S S of the channel or reservoir, contraction takes place at the *ends* of the weir, as shown at A and A, Fig. 8, as well as over the crest. Such contraction diminishes the discharge. A weir of this kind is called a *weir with end contractions*. Other things being equal, the extent of the contraction, and its effect upon the discharge, increases with the head H. When the length A A or L of the weir exceeds about ten times the head H, the effect of the end contraction upon the discharge is nearly imperceptible, but as the length diminishes in proportion to the head, the effect of the contraction increases rapidly. If end contraction is permitted at all, it must be made *complete*; for the coefficients given in the formulas for discharge do not apply to cases of *incomplete contraction*, i.e. with contraction only *partly* suppressed.

The contraction is said to be "complete" when it is practically as great as it could be made by any further increase of the distance A S Fig 6 and 8, and this is believed to be attained when A S is made equal to twice the head H.—Page 265 Trautwine's Engineer's Pocket Book.

Two forms of weir modules will be considered, the rectangular weir, whose sides are vertical, which is the one ordinarily meant when weir is spoken of, and the one which has been the subject of experiment; and the trapezoidal weir proposed by Cippoletti, after a thorough investigation. Its sides are inclined at a slope of one-fourth horizontal to one vertical.

The most complete experimental investigation of the flow of water over weirs has been made by Americans, and the adopted formula is due to one of them. To the careful experiments of the late Jas. B. Francis, Past President American Society Civil Engineers, Honorary member American Society Irrigation Engineers, of Lowell, Mass., is due the ordinary form of the equation of the weir, and to his careful work hydraulic science owes much. * * *

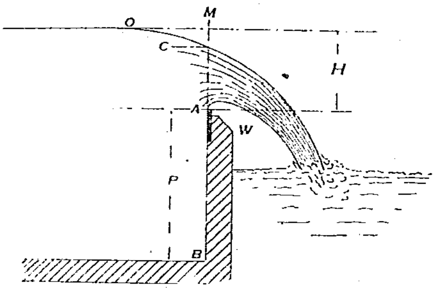

FIGURE 4.

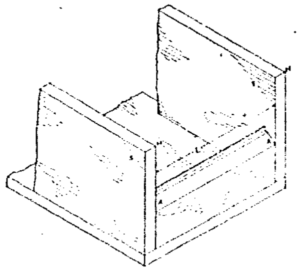

FIGURE 5.

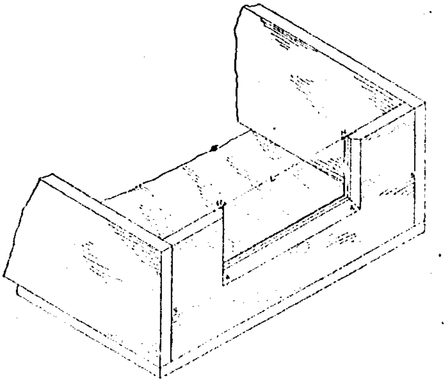

FIGURE 6.

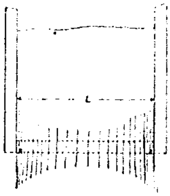

FIGURE 7.

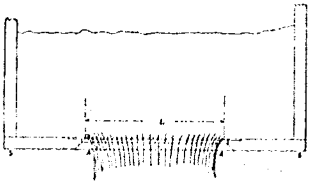

FIGURE 8.

If one observes the flow of water through an orifice, he will notice that the stream becomes narrower at the opening or is subject to lateral contraction. If over a weir, the sheet of water becomes thinner immediately below the crest (as in Fig. 4), or is subject to a vertical contraction. By taking separate account of these two contractions, Francis succeeded better than previous experimenters in producing a formula which represented the discharge. The form of the equation indicated by theory and agreeing closely with Francis' experiments, is of the form.

$$Q=aLH^{n}$$

Where Q=the quantity of water flowing in cubic feet per second, L= the *effective* length of the weir in feet. This is not necessarily the same as the actual length of the weir. It is mentioned more fully on the next page.

H=the depth of water flowing over the weir, in feet. Because of the vertical contraction, this must be measured far enough from the weir to be free from its influence. If the water approaches with a current, this depth needs to be increased by a correction indicated by theory. This correction is troublesome to make. In practice it is better to so reduce the velocity of the current that the correction will be so small that it may be neglected.

a is a numerical coefficient which is needed to multiply the result obtained by the indicated operations in the measured quantities, in order to give Q the discharge.

From his experiments, an abstract of which cannot convey an idea of the care and skill used in the experimentation, Francis adopted the value of 3·33 for *a*.

The formula of Francis then becomes

$$Q = 3.33\ LH^{\frac{3}{2}}$$

where the letters mean the same as above and with the same restrictions.

Q represents the discharge in cubic feet per second.

L and H are both measured in feet and decimals.

An additional word needs to be said regarding L.

L is the *effective* length of the weir, which in case of the rectangular weirs, is not necessarily the same as the actual length.

Attention has already been called to the contraction of a stream as it passes through the weir or other opening. This will be especially noticed in cases where the opening is smaller than the channel leading to it. The formula giving the discharge really consists of several factors, one of which is the velocity of the water passing the weir, and another the sectional area of the stream where it has this velocity. Now the effect of the contraction is to lessen the area, not of the weir, but of the stream passing through it in which the water has the velocity given by the other factor. In consequence, the *effective* length of the weir is shortened. Hence in this formula, for L is used, not the actual length of the sill, but the *effective* length, which is found by applying a correction for the contraction to the measured length.

The amount of this contraction depends upon the distance that the sides are from the parallel sides of the weir. When close, the contraction is small, but when the distance is two or three times the depth on the weir, there seems to be no further change in the contraction with the increased distance. In such case the contraction is said to be complete. From the case of complete contraction there may be all degrees of contraction down to no contraction.

The amount of this contraction, when complete, increases with the depth of water flowing over the weir. It is difficult and unreliable to measure the amount directly. But we again have recourse to the experiments of Francis, from which it is determined that with complete contraction, and the same formula, that if an allowance be made, equivalent to a shortening of the weir equal to one-tenth of the depth of the water flowing over it, for each complete contraction, the discharge will be given, other conditions being correct, within 1 per cent.

Thus, we may take an example.

In a case where the depth is 1.56 feet, and there are two contractions, the effective length of the weir, or the length to be taken in the calculation of the discharge, is not ten feet, but ten feet shortened by two (the number of contractions) times one-tenth of 1.56 feet; or .31 feet less than 10 feet. The effective length is accordingly 9.69 feet. With the same weir, but a depth of .08 feet, the effective length, or the value of L to be used in the computation, is .16 less than 10 feet, or 9.84 feet.

It is seen that the effective length varies with different depths with the same weir. It is because of this, that of two weirs, one twice as long as the other, of the rectangular pattern, the one will not give exactly twice as much as the other, even for the same depths. But if the two have their effective lengths, so that one is twice the other, then the discharge of one will be twice that of the other.

The Cippoletti weir is a form adopted in order that the effective lengths are constantly the same as the measured length of the weir.

The weir here called the Cippoletti weir because of its originator, is one proposed by Cippoletti to meet the conditions which the Italian government laid upon the company which was given a concession of water for the Canale Villoresi, the last of the great Italian canals. * * * In the act of concession to this canal, the government required the company to propose a module

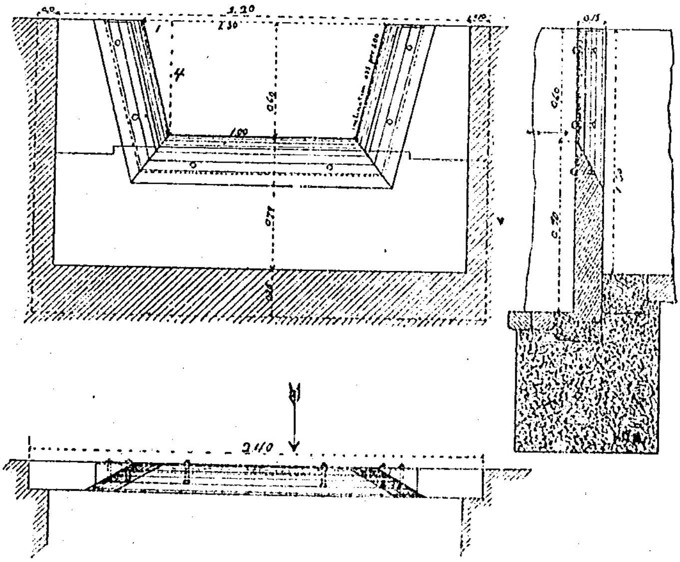

FIGURE 9.—CIPPOLETTI TRAPEZOIDAL WEIR.

for the measurement and sale of water which should be based upon the theory of the weir with free fall, and that the module should be accurate. The problem was put in the able hands of Cesare Cippoletti, the engineer in charge of construction. The problem Cippoletti proposed to himself, was, while preserving the simple and convenient form of the Francis formula, to determine the form and condition of the weir so that the discharge should be proportional to the length of the weir, and so that no single cause should produce an error of more than one half of one per cent.

Taking the experiments made by Francis as a basis, he attempted first to determine a form of the weir in which the contractions at the sides should be automatically overcome.

In the rectangular weir, as already mentioned, the effect of the contraction increases in proportion to the depth. The idea suggested itself to him, that by making the form of the weir so that the area increases by an amount in proportion to the depth on the weir, then if the increase in area can be made so as to exactly balance the loss due to the contraction, the flow through the weir would remain the same as though the weir were rectangular, of the same length of sill, but without contraction. In other words, the effective length would remain the same for all depths. Manifestly, a weir of a trapezoidal shape, like that in Figure 9 presents the condition wherein the increase in area is in proportion to the depth on the weir. This is the fundamental idea in the Cippoletti weir.

This form is equivalent to the rectangular weir, with a triangle added at each end. In order that the flow through the added triangles shall be equal to the amount lost by the contraction, recourse is had to experiments and from calculation, the inclination of the sides is found to be such that a slope of *one horizontal* to *four vertical* would be sufficient, provided the coefficient of contraction remains constant. This is not quite an exact supposition, but the difference is insensible. * * *

The weir measurement is accurate, *provided the proper conditions are observed*, but the conditions for the construction of weirs are not generally known, and less generally observed. It should also be understood that it is safe to apply the formula only within the limits of the experiments on which it is based. The results either by the weir or other orifices, are exact only so far as our experimental knowledge goes. The theory of the flow of water under even the simplest conditions is still too incomplete, and the laws too imperfectly understood to allow of passing much beyond the data with which we are possessed. In order that a weir formula should apply beyond these limits the value of the coefficient a, in the formula would be a varying one. In the Francis formula the coefficient is given a constant value, the disturbing effect of the side contraction being taken into account by varying the value of L. But if the weir be placed so as to meet the following conditions, the formula above given, and the tables attached to this bulletin, may be used with confidence that the result is correct within 1 per cent.

CONDITIONS FOR THE WEIR, EITHER RECTANGULAR OR TRAPEZOIDAL.

In nearly all cases, the weirs placed for measurement, are not placed with sufficient care to make the measurement one of great accuracy. The present demand for water, which is to increase, will gradually require more care in every detail. The weirs commonly used are of timber with board sills and sides, not usually made in a wide enough or deep enough channel.

With the more pressing demand for exact measurement companies will soon be justified in constructing permanent weirs, with much care.

Under the Canale Villoresi where the Cippoletti weir was first used, all the weirs examined by the writer were constructed of cut stone, and the crests and sides were made of iron plates, the whole made with care so as to remain useful for generations to come.

If the following conditions are followed in constructing a weir, whether it be rectangular or trapezoidal, the weir formula may be used with confidence that no single cause will produce an error greater than one half of 1 per cent. The conditions are essentially the same as those either of Francis or of Cippoletti.

1. That the channel leading to the weir be of constant cross-section, its axis passing through the middle of the weir and perpendicular to it; this straight reach to be of such length that the water flows with uniform velocity, without internal agitation or eddies. This should be not less than fifty or sixty feet, more if possible.

2. Only by making the contraction complete on both sides and bottom can the coefficient *a* in the formula have a value free from uncertainty, and to secure complete contraction, it is necessary:

(*a*) that the opening of the weir be made in a plane surface, perpendicular to the course of the water;

(*b*) that the opening itself have a sharp edge on the up-stream face, and its walls cut away so that their thickness at the point of discharge shall not be above 1-10 the depth for depths below 5 inches, nor above ¼ the depth for depths from 5 to 24 inches;

(*c*) that the distance of the sill of the weir from the bottom of the canal be at least three times the depth on the weir;

(*d*) that the distance of the sill of the weir from the sides of the channel, be at least twice the depth of the water flowing over the weir;

(*e*) that the lateral contraction remaining undisturbed, the length of the weir should be three, or better four, times the depth of the water flowing over;

(*f*) that the depth of water flowing over the weir shall not be less than three inches.

3. The velocity of approach must be very small; for weirs three feet long and depth of 12 inches, it ought not to be greater than 6 inches per second; for weirs of six feet long and depth of 24 inches it ought not to be above 8 inches per second. In all these cases the cross-section of the canal of approach ought to be at least seven times that of the weir. Other conditions affecting the velocity of approach are included in *c*, *d* and *e*, respecting complete contraction.

4. The layer of falling water should be perfectly free from the walls below the weir, in order that air may freely circulate underneath. For short weirs it is sufficient that the lateral walls of the lower canal be free from the sides of the weir. In such case, when air freely passes underneath, the level of the water in the lower canal has no influence on the discharge of the weir, unless it reaches or exceeds the level of the crest.

5. The depth of the water should be measured with accuracy where the suction of the flow does not affect the height and where it is free from influences such as the wind, or the movement of the water, which can affect the true level. The height should be read to within 1-300 of the depth in order that the error may be within one-half of 1 per cent.

6. The weir ought to be constructed with care and carefully located. It should not vary more than 4 degrees from being perpendicular to the channel. Its sill should be horizontal.

The disturbing causes may be divided into three classes: those which always tend to increase the discharge over the computed amount; those which always tend to decrease the amount; and those which may either increase or decrease the amount, one being as likely to occur as the other, and in the long run tending to balance each other.

The measurement of the depth of water is in general as likely to be too great as too small, with careful measurement, and the errors due to this may be neglected.

The effect of obliquity of the weir, or of eddies is to decrease the flow below the computed amount.

The effect of any velocity of the water as it approaches the weir, of the nearness of the sides or bottom to the weir, incomplete contraction, of a crest not perfectly sharp, of air not having access beneath the sheet of falling water, etc., the effect of each of these is to increase the discharge.

The causes tending to increase the discharge evidently out number those tending to decrease it, and are, all things being taken into account, more difficult to overcome.

It is frequently not possible to meet all the conditions. But the errors due to the weir not being vertical, or horizontal, or perpendicular to the current, or for crest not being sharp, can be obviated by careful construction.

If the weir is not vertical, the discharge is increased or diminished, according as the inclination may be down or up stream. The correction amounts to 4 per cent for inclinations as great as one horizontal to three vertical, or for angles of about 18 degrees. For less inclinations the correction would be less.

The effect of nearness of the sides in increasing the discharge, amounts to about one per cent. when the distance is equal to the depth of the water on the weir, about ⅓ of one per cent. when the distance is 1½ times the depth, and may be neglected when over twice the depth of water on the weir.

The effect of nearness of floor is to increase the discharge. When the depth below the crest is three times the depth over the weir the increase is insensible; if 2.5 times the depth, is less than one-half of 1 per cent.; if 2 times the depth, nearly 1 per cent.; if equal to the depth, is 1.5 per cent.; and if but one-half the depth, over 2 per cent. The amount of this varies with other conditions.

An increase of temperature seems to increase the discharge, and the presence of sediment has the same effect through action on the surface tension of the liquid. With large openings the effect of the temperature is less than with small. Under present conditions they need to be neglected. Their influence is small.

VELOCITY OF APPROACH.

The velocity of approach is, all things considered, the most difficult to reduce within reasonable limits, and the errors thus introduced in ordinary measurement are the most considerable. It is not possible to entirely prevent velocity in the approaching water, but by properly proportioning the size of the channel to the opening of the weir, the velocity may be reduced to such limits that its effects may be neglected. [A comparison of tables I. and II. for allowing for velocity of approach will show this.] As water is liable at times to carry sediment, the space in front of the weir under most conditions is liable to fill up. The water being thus confined to a smaller cross-section the velocity is augmented, increasing the discharge for the same depth over the weir. It is troublesome to make the computation for the allowance for velocity of approach, the better way being to keep within the bounds indicated by the conditions on page 17, or within limits indicated by study of tables I. and II; but where necessary the following method may be used; with velocity of less than 1.5 feet the result will be correct. For greater velocity it seems probable that the correction is not quite sufficient. It should also be remembered that this correction is only for the additional head due to the velocity.

Let H = the head passing over the weir, measured in quiet water, several feet from the crest,

h = the head which would give the velocity of the water in the channel of approach. This velocity may be found by determining the quantity passing over the weir, by reference to the tables, without correcting for velocity. Then the velocity is

$$v = \frac{Q}{A}$$

Where A is the area of the section of the channel above the weir in square feet, and Q is the quantity in cubic feet per second. Then

$$h = \frac{v^2}{64.4}$$

the denominator being twice the acceleration of gravitation. The correction for velocity is then made by using in the weir formula, $Q = 3.33\ LH^{\frac{3}{2}}$, $H + \frac{3}{2}h$, instead of H, as the depth to be taken.* This form of correction is due to Fteley and Stearns. It gives a much larger correction for velocity than is furnished by the Francis correction, but it agrees much better with measurements I have made for high velocities The experiments on which it was based were limited to velocities of 2.5 feet per second. Table II. gives the per cent. increase in discharge caused by different velocities. It will be seen how great this correction becomes, sometimes causing an increase of several hundred per cent., and, consequently, shows the importance of keeping the velocity within low limits.

To aid in the practical allowance for velocity of approach, two tables have been prepared and are printed as tables I and II of the appendix. Table II shows the increase in per cent. over the quantities given in tables III and IV by various velocities of approach. The increase with a given velocity varies with the depth of water over the weir, being greater for small depths. A velocity of one foot per second increases the discharge over a weir when the water is flowing 3 inches deep, over 14 per cent; if flowing over the weir 1 foot deep, only 3.5 per cent. The table I shows what the average velocity is as the water passes through the weir, or it shows what is the velocity in the channel if the section is the same as that of the weir, as it frequently is. A comparison of the two tables will show the proper section to give the channel in order that the resulting error shall be within reasonable limits.

The Cippoletti form of weir because of the reasons already given has the most advantages of any module known to the writer for measurement of water for irrigation purposes. It is reliable to within 2 per cent. with the Francis formula, if placed according to the conditions given, and probably within 1 per cent. The ordinary methods of measuring or guessing at the discharge of water vary from 40 to 400 per cent., as usually used. All that may be said of its advantages, save the one of having the effective length of the sill in proportion to the actual length of the sill is

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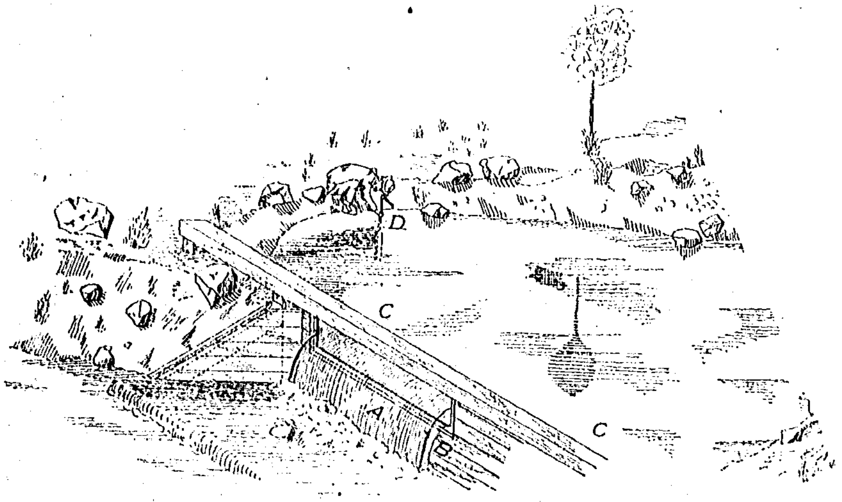
* This is for a rectangular weir with no end contraction or for a Cippoletti weir. In the case of a rectangular weir with two complete end contractions, use H + 2.05h instead of H.

true of the rectangular weir also. It meets most of the conditions for a good module. It lacks means of self-adjustment, or of preserving constant heights of water. Where adapted, the spill-box may be used in connection with it, when that condition would be very nearly met. Several canals have introduced essentially this combination, and so far as reports have reached the writer they have been satisfactory.

MEASURING THE HEAD H.

A correct measurement of the depth of water upon a weir is a delicate matter and cannot be so easily obtained as might be supposed. Waves or ripples and other disturbances of the surface, and capillary attraction, are the chief sources of error. When it is desired to ascertain very accurately and closely the true level of the water surface, and depth upon a weir to still water, a hook gauge should be used. This consists of a long graduated rod, provided at its foot with an upturned hook or point, and sliding vertically (by means of a screw motion) in a fixed support, to which is attached a vernier indicating on the scale the height of the point. The sliding rod is first run down until the point is well below the surface and then gradually raised by means of the screw until the point just reaches the surface, which is indicated by the first appearance of a "pimple" on the water surface immediately over the hook.



SKETCH. SHOWING

A. WATER FLOWING OVER WEIR

B. ACCESS OF AIR TO SPACE UNDER FALLING WATER.

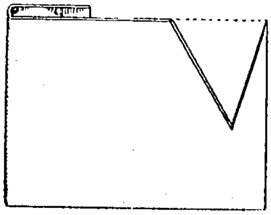
C. STILL WATER ABOVE DAM.

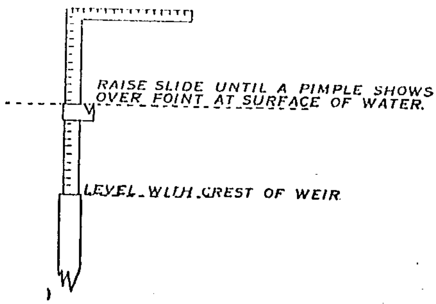
D. MEASUREMENT TAKEN FROM SURFACE OF WATER TO TOP OF STAKE PREVIOUSLY DRIVEN LEVEL WITH CREST OF WEIR.

FIGURE 10.

To avoid inaccuracies due to the disturbance of the surface by the current, by wind, etc., the level is sometimes taken (with the hook-gauge or otherwise) in a side chamber which communicates with the main channel of approach. The surface in the chamber maintains the same level as that in the channel itself, but is comparatively free from disturbance. Or a bucket communicating with the channel by means of a pipe, can be made to serve in the same way. Either may, of course, be sheltered from the wind.

For rougher and approximate measures a post is usually set at an accessible point on one side of the channel, above the weir, and its top cut off level at the exact level of the weir crest. The depth of the water is then measured by a rule placed vertically on the top of this post and observed with care—see figure 10. If a tin or metal slide is used with the rule with a sharp point to indicate the exact surface of the water, a closer reading may be had than by the use of the rule alone—see figure 11.





TIN SLIDE. TO BE USED ON A STEEL SQUARE, THUS

FIGURE 11.

For measures taken when there is no danger from freezing, the following arrangement is a very convenient one: A pipe, say three-fourth inch lead, is passed from dead water a little above the weir, through or around the weir, and connected to a vertical glass water tube set below the weir at a convenient point of observation. In such case a scale with five graduations is fastened against the glass with its zero level with the crest of the weir. The depth of water on the weir can then be read off at a glance quite accurately.

The height may be measured by means of a brass or other scale provided with diagonal inclined bars, as in figure 12, so that a rise or fall of, say, one-tenth of a foot would cause the water to rise or fall on the scale three or four or five tenths of a foot, depending upon the angle at which the diagonal bars are placed. Page 298, Treatise on Hydraulic and Water Supply Engineering. Fanning.

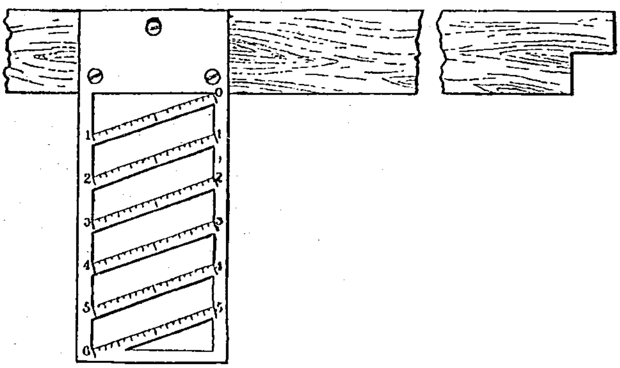


FIGURE 12.

DESIGN.

The dimensions of the notch should be ample to carry the entire stream, and yet not so long that the depth of water on the crest shall be less than three or four inches.

Where the flow of the stream to be measured varies considerably during the season, it is necessary to provide for increasing or shortening the length of the weir, so that the proper proportions of width and depth may be maintained. This may be accomplished by the use of vertical stop planks with flared or bevelled edges placed at one or both ends of the weir.

If it is found necessary to make the notch of the entire width of the stream so that there will be no end contractions, partition boards will have to be placed against the upper side of the weir flush with its shoulders and at right angles to its plane, as in figure 5.

It may happen that the weir may be so long as to require intermediate posts in its frame-work, so that there will be really two or more weir notches, instead of one, as in figures 13 and 14. In this case proper allowance must be made for end contractions at the posts as well as at the outer ends. The distance from the vertical edge of the weir notch on one side of a post to the vertical edge of the weir notch on the other side of the post should not be less than four times the depth of the water flowing over the weir, in order to insure complete contraction. If it is not practicable to allow this distance, boards should be placed against the upper side of the weir flush with the vertical edges on either side of the post at right angles to the weir, and extending down into the water a few inches below the crest, so as to entirely suppress the contractions due to the introduction of the posts. As has been said, the discharge formulas apply only to cases of "no contraction" or to cases of "complete contraction," and care must be taken to see that the conditions are such as to insure one or the other of these.

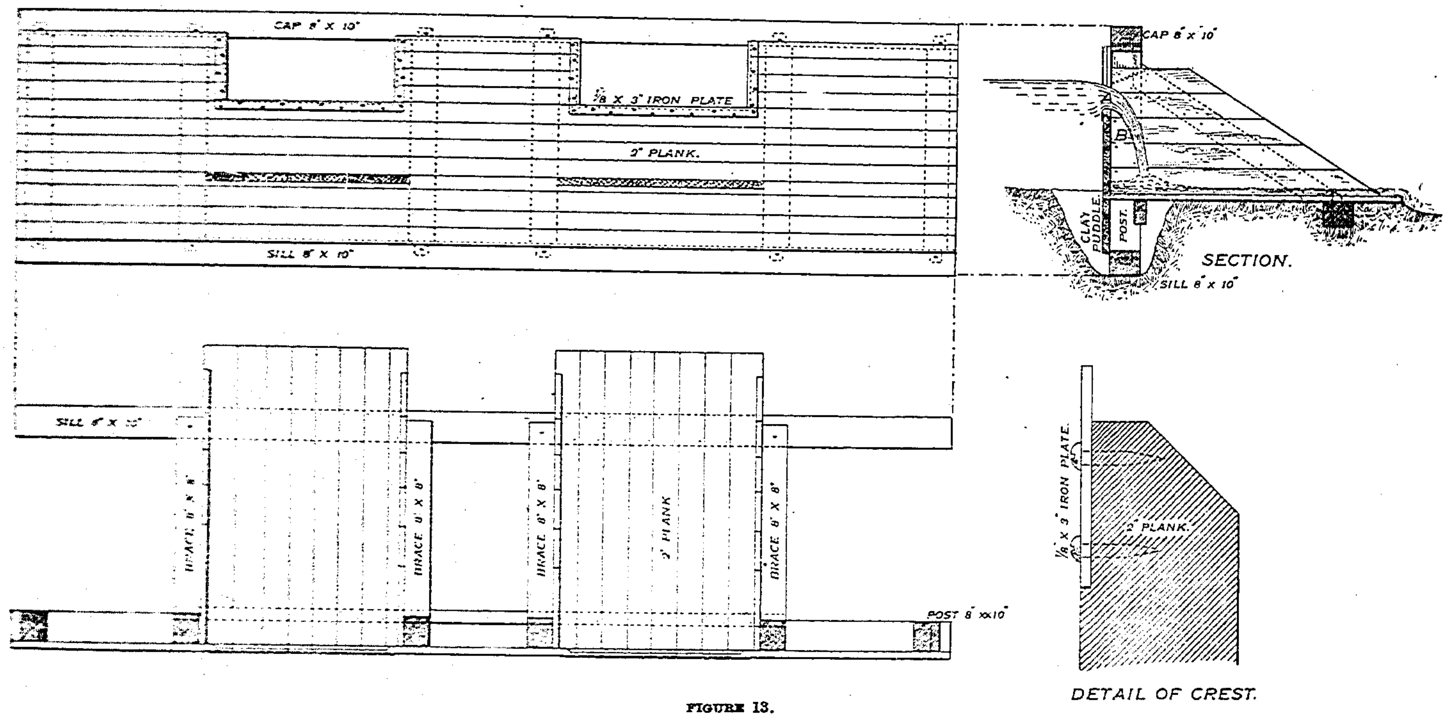

CAP 8" X 10"
1/8 X 3" IRON PLATE
2" PLANK.
SILL 8" X 10"
SILL 8" X 10"
BRACE 8" X 8"
BRACE 8" X 8"
BRACE 8" X 8"
2" PLANK
BRACE 8" X 8"
POST 8" X 10"
CAP 8" X 10"
A
B
CLAY PUDDLE.
POST.
SECTION.
SILL 8" X 10"
1/8 X 3" IRON PLATE.
2" PLANK.
DETAIL OF CREST.

FIGURE 13.

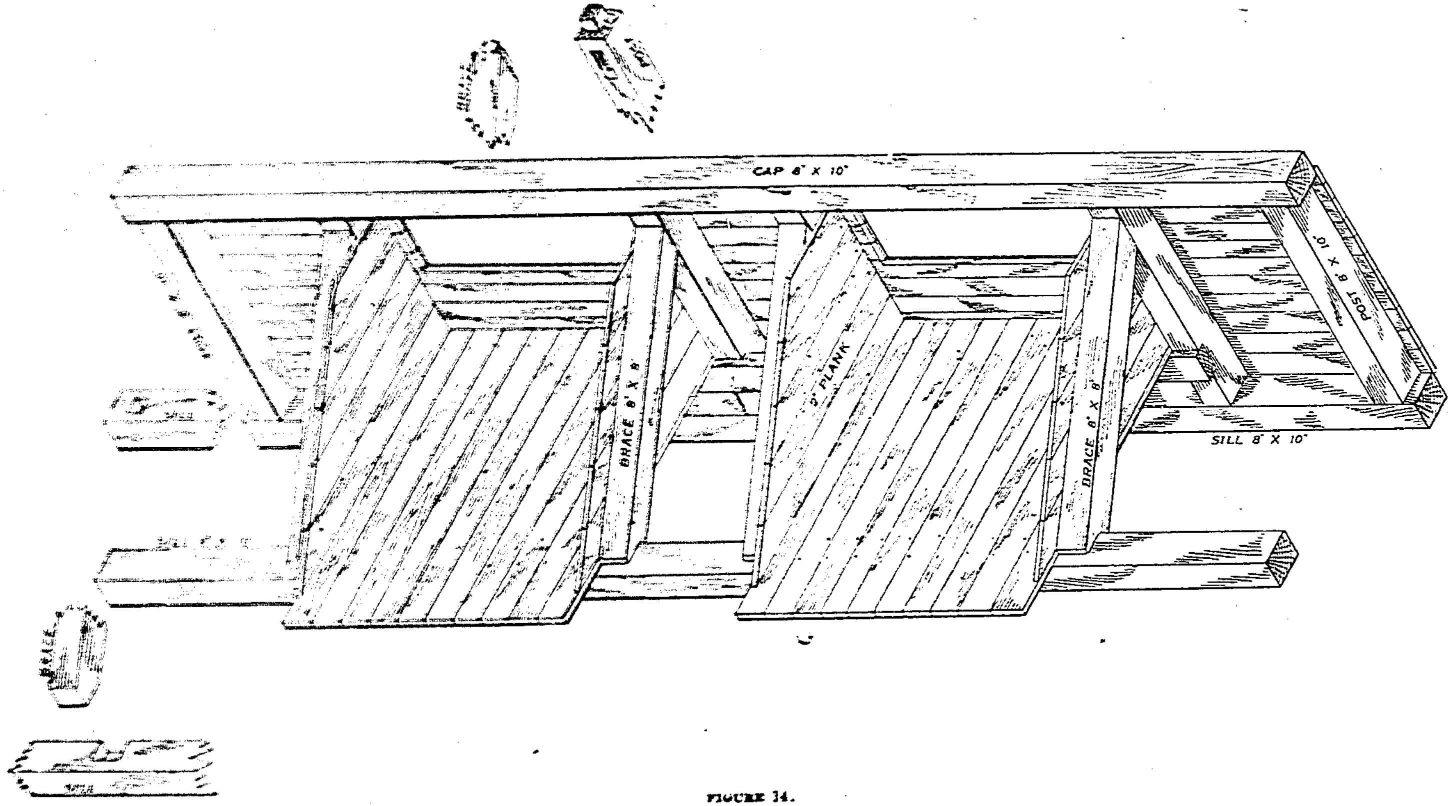


FIGURE 34.

"Figs. 15 and 16 are designs for small measuring weirs, suitable for shallow streams up to say 100 feet wide; Fig. 15 for earth or gravel bottom, and Fig. 16 for rock.

In the former, the 8×10 inch hemlock sills S_1 and S_3 are first laid across the bottom of the stream, which is trenched where necessary; care being taken to lay S_1 in a true line. The sills should extend say from 5 to 10 feet into each bank of the stream. Tongued and grooved sheet piling P, of 3×10 inch hemlock, is then driven close behind the upper sill S_1 to a depth of from two to four feet, and spiked to S_1. A third sill, S_2, of the same length as S_1 and S_3, is then laid behind the sheet piling, and the two sills S_1 and S_2 and the sheet piling P are secured together, as shown, by 1 inch bolts, spaced about 2 feet apart. The tops of the sheet piling project about a foot above the sills, and are stiffened by 4×4 inch timbers *W*, bolted in front of them and resting upon the flooring *F* of 2×10 inch spruce. This flooring, like the sills, extends several feet beyond each end of the weir into the bank, and is there loaded to its full capacity with heavy stones. Any spaces left underneath it by unevenness of the bottom should also be leveled up with stones or gravel.

A 10×10 inch yellow pine post M, 3 feet high, is tenoned between sills S_2 and S_1 at each end of the overflow, and braced by an 8×10 inch yellow pine strut N, tenoned to it and to the sill S_3. Beyond these posts the sheet piling P extends as high as the top of the posts, and is carried at that height into the bank; the tops of the piles being held in line by two 2×8 inch walling pieces *U U* bolted to them, one on each side.

In Fig. 16, the hemlock sills, S_1 of 10×10 inch, and S_2 of 6×8 inch, rest upon a Portland cement masonry wall, of varying height to accommodate the inequalities of the rock bottom; and are secured to it by 1 inch bolts spaced about 4 feet apart. These bolts pass down through the masonry, as shown, and a foot or more into the rock below.

Between the two sills are bolted upright 3×10 inch tongued and grooved hemlock planks P, 15 inches long. At each end of the weir, a 10×10 inch yellow pine post M is tenoned between the sills, as in Fig. 15, and built into the masonry ends of the dam, which last extend well into the banks of the stream.

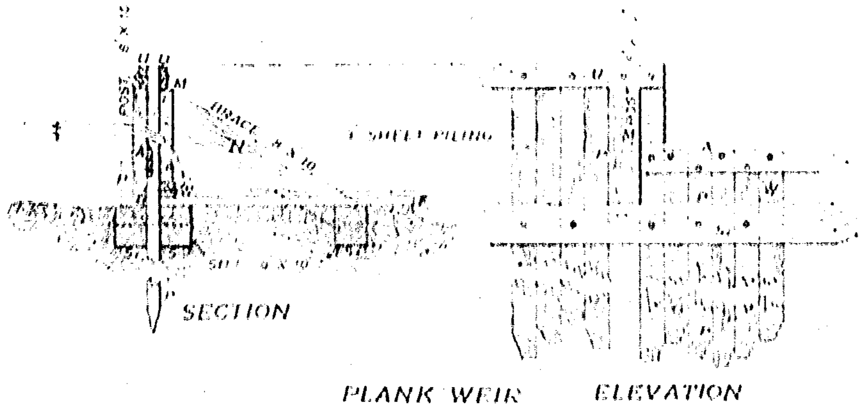


FIGURE 15.—MEASURING WEIR ON EARTH OR GRAVEL BOTTOM.

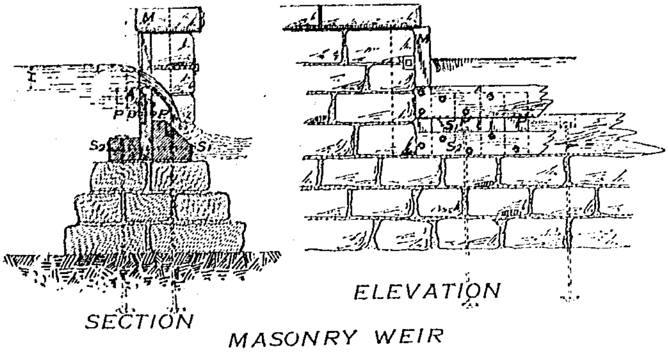


FIG. 16.—MEASURING WEIR ON ROCK BOTTOM.

It both Figs. the crest-piece *A*, is of 2×8 inch oak beveled so as to leave a horizontal top face ½ inch wide. The crest piece is let in flush with the back of the piles or boards P, to which it is bolted, and is let into the end posts M about 2 or 3 inches. At low stages of water the flow may be confined to a *portion* of the length of the overfall by flash-boards placed along the rest of the dam.

A crest-piece made of 8×¼ inch bar iron is preferable to one of wood. It requires of course much less cutting away of the sheet-piling, and its upper edge is less subject to abrasion by drift passing over the weir. The top edge, and the abutting ends of the several lengths, should be planed smooth and square; the former to insure a sharp inner corner at *A* for the water to pass over, and the other in order to avoid leakage. As a further precaution against leakage, a strip or butt-strap of 8×⅛ iron, about a foot long, may be let in, *between the crest-piece and the sheet piling*, opposite each joint of the former, and overlapping both the adjoining ends, the piling being cut away ⅛ inch deeper at those points, in order to accommodate them. Such butt-straps, if placed on the *up*-stream side of the crest-piece, would break the continuity of the sheet of water passing over the weir, and thus interfere somewhat with the correctness of the gauging.

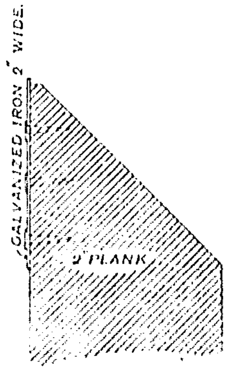
All the joints should be caulked with oakum. To apply the usual weir formulæ (see pages 1 and 14) the back ot the weir should be vertical for a depth *P* below the crest *A* equal at least to twice the head H on the weir. It is therefore better to protect the back of the weir by tarpaulin rather than resort to puddling, except close to the bottom.

In a long weir with a low fall, it is difficult to secure a sufficiently free access of air to the space behind the falling sheet of water, especially when the stream is low and the sheet tends to hug the face of the dam. In such cases a partial vacuum forms between the falling sheet and the face of the dam, and increases the discharge, thus vitiating the results. It is therefore important in designing measuring weirs, to arrange (as far as possible) so that the sheet of water may fall clear through the entire distance between the up-stream and down-stream levels without striking any portion of the weir itself, for such striking would diminish the clear space behind the sheet and increase the difficulty of preventing a vacuum there."—Pages 286 and 287 Trautwine's Engineer's Pocket Book.

Another form of construction is shown in Figures 13 and 14, which are sufficiently in detail to make a written description unnecessary. Plank should be put on the sills at the two ends and between the two weir notches, and be loaded with stones and dirt. This form could be used on a mountain stream where the flood waters are not to be measured and in place of one of the weir notches a gate could be placed to allow the flood waters to pass. After the subsidence of the flood the gates could be closed and all the water forced through the weir notch. Other forms of construction equally good might be designed and employed.

The weir should be stoutly built and care should be taken to make the foundation firm, the bracing substantial, and the planking rigid, so there will be no vibration of the frame work or crest; and the sheet piling or planking should go down deep, and well into the banks on each side, so that there will be no leakage under or around it. A solid apron should be provided to receive the falling water and prevent undermining.

Figure 17 shows a detail of crest of a sharp-crested weir. Figure 18 shows the slope of the sides of a trapezoidal weir, necessary to compensate for end contractions.



DETAIL OF CREST

FIGURE 17.

TRAPEZOIDAL WEIR.

FIGURE 18.

EXPLANATION OF TABLES.

Tables I and II in the appendix are for the purpose of correcting to allow for the errors due to velocities in the approaching water without the troublesome calculations indicated.

Table I is an auxiliary table giving the average velocity through the weir for different velocities over the weir. It may be used to determine the velocity of the water as it approaches the weir, under known conditions, or with the aid of the second table, to determine the proper conditions of the size of the channel, in order to bring the errors within assigned limits. The velocity given is the average velocity in the plane of the weir. If, then, the cross-section of the channel above the weir is no larger than the weir itself, the velocity of the water through the section would be the same as that of the table. If the section is twice that of the weir, then the velocity is one-half that of the table.

Table II is computed from the Fteley formula on page 19, and expresses the increase due to velocity over that given in the tables III-V. To use, the discharge as given in tables III-V is determined, and the correction is applied according to the given depth over the weir and the velocity of approach. The correction is expressed in per cent. The formula is based on experiments limited to 2.5 feet per second. For greater velocities, therefore, it is possible that the quantities given are in error.

EXAMPLE—What correction to allow for the velocity of two feet per second, the water passing over weir 1 foot deep. Find at the top the column with depth 1 foot, and at left find line with velocity of 2 feet per second. Follow the line to the right and in the column with depth 1 foot the number 14.3 is found which is the number of per cent, by which the discharge is increased.

The preceding text was compiled, and Table III was computed, by the former state engineer, Willard Young, now Col. of 2nd Reg. U. S. Vol. Engrs. The work of preparing for the press, and of making the computations for Table IV, was done by the present state engineer, R. C. Gemmell.

Table III is computed from the formula, $Q = 3.33\ L\ H^{\frac{3}{2}}$, Q being in cubic feet per second, L and H in feet. The discharge is given for a weir one foot long, and for all depths up to 36 inches, the depths varying by thirty-seconds of an inch. Where there are two complete end contractions, the amounts to be subtracted are given in the fourth column.

EXAMPLE.—What is the discharge over a weir 52 inches long under a head of $12\frac{1}{16}$ inches, with two complete end contractions?

$12\frac{1}{16}$ inches is the same thing as $12\frac{2}{32}$ inches. On page 32 find the discharge corresponding to a head of $12\frac{2}{32}$ inches for a weir one foot long, which is 3.3550 cubic feet per second. 52 inches is equivalent to 4 feet and 4 inches or $4\frac{1}{3}$ feet. Then for a weir $4\frac{1}{3}$ feet long the discharge is $4\frac{1}{3}$ times 3.3550=14.5383 cubic feet per second, if without end contractions. For two complete end contractions the amount to be subtracted, found in the fourth column, is .6744 cubic feet per second. The total discharge, then, would be 14.5383 minus .6744=13.8639 cubic feet per second.

Table IV is computed from the formula $Q = 3.33\ (L - .2H)\ H^{\frac{3}{2}}$. This table gives the discharge with two complete contractions for all depths up to 36 inches, the depths varying by sixteenths of an inch, and for various lengths of weir, without the necessity of calculations of any kind whatever.

EXAMPLES.—What is the discharge over a weir $1\frac{1}{2}$ feet long under a head of $4\frac{1}{16}$ inches, with two complete end contractions?

Under column headed "$1\frac{1}{2}$ feet long" on page 39 find the discharge corresponding to the head, H, of $4\frac{1}{16}$ inches, which is .9454 cubic feet per second.

What is the discharge over a weir 5 feet long under a head of $12\frac{1}{2}$ inches, with two complete end contractions?

Under the column headed "5 Feet Long" on page 43, will be found two discharges corresponding to the head, H, of $12\frac{1}{2}$ inches. This is due to the fact that $\frac{1}{16}$ of an inch is not exactly equivalent to .005 of a foot. In order to obtain the exact result, add the two discharges together and divide by 2, thus: $\frac{16.9244+17.0430}{2}=\frac{33.9674}{2}=16.9837$ cubic feet per second.

Table V is computed from the formula $Q=3.3\frac{2}{3}\ L\ H^{\frac{3}{2}}$. It is to be used for obtaining the discharge over Cippoleti trapezoidal weirs, and for rectangular weirs without end contractions gives a discharge about 1 per cent too great. This table is copied from Bulletin No. 27, State Agricultural College, Fort Collins, Colo.

Depth in all cases in the following tables is measured to still water.

TABLE I.

Auxiliary Table for Approximating to Velocity of Approach.

Depth of water over weir.		Average velocity in section of weir.	Depth of water over weir.		Average velocity in section of weir.
In ft.	In in.	In ft. per sec.	In ft.	In in.	In ft. per sec.
.25	3	1.665	1.75	21	4.400
.50	6	2.354	2.00	24	4.709
.75	9	2.881	2.25	27	4.995
1.00	12	3.330	2.50	30	5.265
1.25	15	3.723	2.75	33	5.510
1.50	18	4.078	3.00	36	5.765

TABLE II.

Corrections in per cent for velocity of approach, to be applied to values obtained from tables III to V.

Velocity.	Head.*	DEPTH OVER WEIR, IN FEET.											
		.25	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
.25	.0010	00.8	00.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
.50	.0039	03.5	1.8	1.2	0.9	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3
.75	.0087	08.0	4.0	2.6	2.0	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.7
1.00	.0155	14.3	7.1	4.7	3.5	2.8	2.3	2.0	1.8	1.6	1.4	1.3	1.2
1.25	.0243	22.6	11.1	7.4	5.5	4.4	3.7	3.1	2.7	2.4	2.2	2.0	1.8
1.50	.0350	33.1	16.1	10.7	8.0	6.4	5.3	4.5	4.0	3.5	3.2	2.9	2.6
1.75	.0476	45.7	22.2	14.6	10.9	8.7	7.2	6.2	5.4	4.8	4.3	3.9	3.6
2.00	.0622	60.9	29.2	19.2	14.3	11.4	9.5	8.1	7.1	6.3	5.6	5.1	4.7
2.25	.0787	78.6	37.4	21.5	18.2	14.5	12.0	10.3	9.0	8.0	7.2	6.5	6.0
2.50	.0971	99.1	46.7	30.5	22.6	18.0	14.9	12.7	11.1	9.9	8.9	8.0	7.4
2.75	.1175	121.8	56.9	37.0	27.4	21.8	18.0	15.4	13.4	11.9	10.7	9.7	8.9
3.00	.1398	149.4	69.1	44.8	33.1	26.2	21.7	18.5	16.1	14.3	12.8	11.7	10.7
3.25	.1641	179.6	82.3	53.1	39.1	30.9	25.6	21.8	19.0	16.9	15.1	13.7	12.6
3.50	.1903	213.5	96.9	61.7	45.7	36.1	29.9	25.4	22.2	19.6	17.6	16.0	14.6
3.75	.2185	251.3	113.0	72.3	53.0	41.8	34.5	29.4	25.6	23.6	20.3	18.4	16.8
4.00	.2486	293.1	130.7	82.6	60.9	47.9	39.5	33.6	29.2	25.9	23.2	21.0	19.2

*Head $=\frac{v^2}{64.36}$ v being velocity in feet per second, in first column.

TABLE III.

Discharge in cubic feet per second for each foot in length of a rectangular weir with no end contractions and with a velocity of approach less than six inches per second, by the Francis formula:

$$\text{Discharge} = 3.33 \times \left(\text{length} - \text{number of end contractions} \times \frac{\text{head H}}{10}\right) \times H^{\frac{3}{2}}.$$

HEAD H. In inches (approximately.)	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H. In inches (approximately.)	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H. In inches.	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to besubtracted to give discharge with two complete end contractions.
1-32	.0025	0.0006	.0000	15-32	.1225	.1428	.0035	29-32	.2425	.3976	.0193
2-32	.0050	.0012	.0000	16-32	.1250	.1472	.0037	30-32	.2450	.4038	.0198
3-32	.0075	.0022	.0000	17-32	.1275	.1516	.0039	31-32	.2475	.4100	.0203
4-32	.0100	.0033	.0000	18-32	.1300	.1561	.0041	3 inches	.2500	.4162	.0208
5-32	.0125	.0047	.0000	19-32	.1325	.1606	.0043	1-32	.2525	.4225	.0213
6-32	.0150	.0061	.0000	20-32	.1350	.1652	.0045	2-32	.2550	.4288	.0219
7-32	.0175	.0077	.0000	21-32	.1375	.1698	.0046	3-32	.2575	.4351	.0224
8-32	.0200	.0094	.0000	22-32	.1400	.1744	.0048	4-32	.2600	.4415	.0230
9-32	.0225	.0113	.0000	23-32	.1425	.1791	.0051	5-32	.2625	.4479	.0235
10-32	.0250	.0132	.0001	24-32	.1450	.1839	.0054	6-32	.2650	.4543	.0241
11-32	.0275	.0152	.0001	25-32	.1475	.1886	.0055	7-32	.2675	.4607	.0246
12-32	.0300	.0173	.0001	26-32	.1500	.1934	.0057	8-32	.2700	.4672	.0252
12-32	.0325	.0195	.0001	27-32	.1525	.1983	.0060	9-32	.2725	.4737	.0258
13-32	.0350	.0218	.0001	28-32	.1550	.2032	.0063	10-32	.2750	.4802	.0264
14-32	.0375	.0242	.0002	28-32	.1575	.2081	.0065	11-32	.2775	.4868	.0270
15-32	.0400	.0266	.0002	29-32	.1600	.2131	.0068	12-32	.2800	.4934	.0276
16-32	.0425	.0292	.0002	30-32	.1625	.2181	.0071	12-32	.2825	.5000	.0282
17-32	.0450	.0318	.0003	31-32	.1650	.2232	.0074	13-32	.2850	.5067	.0289
18-32	.0475	.0345	.0003	2 inches	.1675	.2283	.0076	14-32	.2875	.5133	.0295
19-32	.0500	.0372	.0003	1-32	.1700	.2334	.0079	15-32	.2900	.5200	.0301
20-32	.0525	.0401	.0004	2-32	.1725	.2386	.0082	16-32	.2925	.5268	.0308
21-32	.0550	.0430	.0005	3-32	.1750	.2438	.0086	17-32	.2950	.5336	.0315
22-32	.0575	.0459	.0005	4-32	.1775	.2490	.0088	18-32	.2975	.5404	.0322
23-32	.0600	.0489	.0005	5-32	.1800	.2543	.0091	19-32	.3000	.5472	.0329
24-32	.0625	.0521	.0006	6-32	.1825	.2596	.0094	20-32	.3025	.5540	.0335
25-32	.0650	.0552	.0007	7-32	.1850	.2650	.0098	21-52	.3050	.5609	.0342
26-32	.0675	.0585	.0008	8-32	.1875	.2704	.0101	22-32	.3075	.5678	.0349
27-32	.0700	.0617	.0009	9-32	.1900	.2758	.0105	23-32	.3100	.5748	.0357
28-32	.0725	.0651	.0010	10-32	.1925	.2813	.0108	24-32	.3125	.5817	.0364
29-32	.0750	.0684	.0010	11-32	.1950	.2867	.0111	25-32	.3150	.5887	.0371
30-32	.0775	.0718	.0011	12-32	.1975	.2922	.0115	26-32	.3175	.5957	.0378
31-32	.0800	.0753	.0012	13-32	.2000	.2978	.0119	27-32	.3200	.6028	.0386
1 inch	.0825	.0789	.0013	14-32	.2025	.3034	.0123	28-32	.3225	.6099	.0393
1-32	.0850	.0825	.0014	15-32	.2050	.3091	.0127	29-32	.3250	.6170	.0401
2-32	.0875	.0862	.0015	16-32	.2075	.3148	.0131	30-32	.3275	.6241	.0409
3-32	.0900	.0899	.0016	17-32	.2100	.3205	.0135	31-32	.3300	.6313	.0417
4-32	.0925	.0937	.0017	18-32	.2125	.3262	.0139	4 inches	.3325	.6385	.0425
5-32	.0950	.0975	.0018	19-32	.2150	.3320	.0143	1-32	.3350	.6457	.0433
5 32	.0975	.1014	.0019	20-32	.2175	.3378	.0147	2-32	.3375	.6529	.0441
6-32	.1000	.1053	.0021	20-32	.2200	.3436	.0151	3-32	.3400	.6602	.0449
7-32	.1025	.1093	.0022	21-32	.2225	.3495	.0155	4-32	.3425	.6675	.0457
8-32	.1050	.1134	.0024	22-32	.2250	.3554	.0160	4-32	.3450	.6748	.0466
9-32	.1075	.1174	.0025	23-32	.2275	.3613	.0164	5-32	.3475	.6821	.0474
10-32	.1100	.1216	.0027	24-32	.2300	.3673	.0169	6-32	.3500	.6895	.0482
11-32	.1125	.1257	.0028	25-32	.2325	.3733	.0174	7-32	.3525	.6969	.0491
12-32	.1150	.1299	.0030	26-32	.2350	.3794	.0179	8-32	.3550	.7043	.0500
13-32	.1175	.1341	.0031	27-32	.2375	.3854	.0183	9-32	.3575	.7118	.0509
14-32	.1200	.1384	.0033	28-32	.2400	.3915	.0188	10-32	.3600	.7193	.0518

HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
In inches (approximately.)	In feet.			In inches (approximately.)	In feet.			In inches.	In feet.		
11-32	.3625	.7268	.0527	5-32	.5125	1.2217	.1252	30-32	.6625	1.7956	.2379
12 32	.3650	.7343	.0536	6-32	.5150	1.2307	.1268	31-32	.6650	1.8058	.2403
13-32	.3675	.7419	.0545	7-32	.5175	1.2397	.1283	8 inches	.6675	1.8160	.2424
14-32	.3700	.7495	.0555	8-32	.5200	1.2487	.1299	1 32	.6700	1.8262	.2447
15-32	.3725	.7571	.0564	9-32	.5225	1.2577	.1314	2-32	.6725	1.8364	.2470
16-32	.3750	.7647	.0574	10-32	.5250	1.2667	.1330	3-32	.6750	1.8467	.2493
17-32	.3775	.7723	.0583	11-32	.5275	1.2758	.1346	4-32	.6775	1.8570	.2516
18-32	.3800	.7800	.0593	12-32	.5300	1.2849	.1362	5-32	.6800	1.8673	.2540
19-32	.3825	.7877	.0603	12-32	.5325	1.2940	.1378	6-32	.6825	1.8776	.2563
20-32	.3850	.7955	.0613	13-32	.5350	1.3031	.1394	7-32	.6850	1.8879	.2586
21-32	.3875	.8032	.0632	14-32	.5375	1.3122	.1410	8-32	.6875	1.8982	.2610
22-32	.3900	.8110	.0632	15-32	.5400	1.3214	.1427	9-32	.6900	1.9086	.2634
23-32	.3925	.8188	.0642	16-32	.5425	1.3306	.1443	10-32	.6925	1.9190	.2658
24-32	.3950	.8267	.0653	17-32	.5450	1.3398	.1460	11 32	.6950	1.9294	.2682
25-32	.3975	.8345	.0663	18-32	.5475	1.3490	.1477	12-32	.6975	1.9398	.2706
26-32	.4000	.8424	.0674	19-32	.5500	1.3583	.1494	13-32	.7000	1.9503	.2731
27-32	.4025	.8503	.0685	20-32	.5525	1.3676	.1511	14-32	.7025	1.9607	.2755
28-32	.4050	.8583	.0696	21-32	.5550	1.3768	.1528	15-32	.7050	1.9712	.2780
28-32	.4075	.8662	.0706	22 32	.5575	1.3862	.1546	16-32	.7075	1.9817	.2804
29-32	.4100	.8742	.0717	23-32	.5600	1.3955	.1563	17-32	.7100	1.9922	.2829
30-32	.4125	.8822	.0728	24-32	.5625	1.4048	.1580	18-32	.7125	2.0027	.2854
31-32	.4150	.8903	.0739	25-32	.5650	1.4142	.1598	19-32	.7150	2.0133	.2879
5 inches	.4175	.8983	.0750	26-32	.5675	1.4236	.1615	20-32	.7175	2.0238	.2904
1-32	.4200	.9064	.0761	27-32	.5700	1.4330	.1633	20-32	.7200	2.0344	.2929
2-32	.4225	.9145	.0772	28-32	.5725	1.4424	.1651	21-32	.7225	2.0450	.2956
3-32	.4250	.9226	.0784	29-32	.5750	1.4519	.1669	22-32	.7250	2.0557	.2981
4-32	.4275	.9308	.0796	30-32	.5775	1.4614	.1687	23-32	.7275	2.0663	.3007
5-32	.4300	.9390	.0808	31-32	.5800	1.4709	.1706	24-32	.7300	2.0770	.3033
6-32	.4325	.9472	.0819	7 inches	.5825	1.4804	.1725	25-32	.7325	2.0877	.3059
7-32	.4350	.9554	.0831	1-32	.5850	1.4900	.1744	26-32	.7350	2.0983	.3084
8-32	.4375	.9636	.0843	2-32	.5875	1.4995	.1762	27-32	.7375	2.1091	.3111
9-32	.4400	.9719	.0855	3-32	.5900	1.5091	.1781	28-32	.7400	2.1198	.3137
10-32	.4425	.9802	.0867	4-32	.5925	1.5187	.1800	29-32	.7425	2.1306	.3164
11-32	.4450	.9885	.0880	4-32	.5950	1.5283	.1819	30-32	.7450	2.1414	.3191
12-32	.4475	.9968	.0892	5-32	.5975	1.5379	.1838	31-32	.7475	2.1521	.3217
13-32	.4500	1.0052	.0904	6-32	.6000	1.5476	.1857	9 inches	.7500	2.1629	.3244
14-32	.4525	1.0136	.0917	7-32	.6025	1.5573	.1877	1-32	.7525	2.1737	.3271
15-32	.4550	1.0220	.0930	8-32	.6050	1.5670	.1896	2-32	.7550	2.1846	.3299
16-32	.4575	1.0304	.0943	9-32	.6075	1.5767	.1916	3-32	.7575	2.1954	.3326
17-32	.4600	1.0389	.0956	10-32	.6100	1.5865	.1936	4-32	.7600	2.2063	.3353
18-32	.4625	1.0474	.0969	11-32	.6125	1.5962	.1955	5-32	.7625	2.2172	.3381
19-32	.4650	1.0559	.0982	12-32	.6150	1.6060	.1975	6-32	.7650	2.2281	.3409
20-32	.4675	1.0644	.0995	13-32	.6175	1.6158	.1995	7-32	.7675	2.2390	.3437
20-32	.4700	1.0730	.1009	14-32	.6200	1.6257	.2016	8-32	.7700	2.2500	.3465
21-32	.4725	1.0816	.1022	15-32	.6225	1.6355	.2036	9-32	.7725	2.2610	.3493
22-32	.4750	1.0901	.1035	16-32	.6250	1.6454	.2057	10-32	.7750	2.2719	.3521
23-32	.4775	1.0988	.1049	17-32	.6275	1.6553	.2078	11-32	.7775	2.2830	.3550
24-32	.4800	1.1074	.1063	18-32	.6300	1.6652	.2099	12-32	.7800	2.2940	.3579
25-32	.4825	1.1161	.1077	19-32	.6325	1.6751	.2119	12-32	.7825	2.3050	.3608
26-32	.4850	1.1248	.1091	20-32	.6350	1.6950	.2140	13-32	.7850	2.3161	.3637
27-32	.4875	1.1335	.1105	21-32	.6375	1.6950	.2161	14-32	.7875	2.3271	.3665
28-32	.4900	1.1422	.1119	22-32	.6400	1.7050	.2182	15-32	.7900	2.3382	.3694
29-32	.4925	1.1509	.1133	23-32	.6425	1.7150	.2203	16-32	.7925	2.3493	.3724
30-32	.4950	1.1597	.1148	24-32	.6450	1.7550	.2225	17-32	.7950	2.3605	.3754
31-32	.4975	1.1685	.1162	25-32	.6475	1.7850	.2247	18-32	.7975	2.3716	.3763
6 inches	.5000	1.1773	.1177	26-32	.6500	1.7451	.2269	19-32	.8000	2.3828	.3818
1-32	.5025	1.1861	.1192	27-32	.6525	1.7552	.2201	20-32	.8025	2.3939	.3842
2-32	.5050	1.1950	.1207	28-32	.6550	1.7652	.2312	21-32	.8050	2.4051	.3872
3-32	.5075	1.2039	.1222	28-32	.6575	1.7754	.2335	22-32	.8075	2.4163	.3902
4-32	.5100	1.2128	.1237	29-32	.6600	1.7855	.2357	23-32	.8100	2.4276	.3933

HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
In inches (approximately.)	In feet.			In inches (approximately.)	In feet.			In inches.	In feet.		
21-32	.8125	2.4388	.3963	18-32	.9625	3.1444	.6053	11-32	1.1125	3.9074	.8694
25-32	.8150	2.4501	.3994	19-32	.9650	3.1567	.6093	12-32	1.1150	3.9206	.8743
26-32	.8175	2.4614	.4025	20-32	.9675	3.1690	.6132	13-32	1.1175	3.9338	.8792
27-32	.8200	2.4727	.4055	20-32	.9700	3.1813	.6172	14-32	1.1200	3.9470	.8841
28-32	.8225	2.4840	.4086	21-32	.9725	3.1936	.6212	15-32	1.1225	3.9602	.8890
29-32	.8250	2.4953	.4117	22-32	9750	3.2059	.6252	16-32	1.1250	3.9735	.8940
30-32	.8275	2.5066	.4148	23-32	.9775	3.2182	.6291	17-32	1.1275	3.9867	.8990
31-32	.8300	2.5180	.4180	24-32	.9800	3.2306	.6333	18-32	1.1300	4.0000	.9040
10 inches	.8325	2.5294	.4211	25-32	.9825	3.2430	.6373	19-32	1.1325	4.0133	.9090
1-32	.8350	2.5408	.4243	26-32	.9850	3.2554	.6414	20-32	1.1350	4.0266	.9140
2-32	.8375	2.5522	.4275	27-32	.9875	3.2678	.6454	21 32	1.1375	4.0399	.9190
3-32	.8400	2.5637	.4307	28-32	.9900	3.2802	.6495	22-32	1.1400	4.0532	.9241
4-32	.8425	2.5751	.4339	29-32	.9925	3.2926	.6536	23-32	1.1425	4.0665	.9292
4-32	.8450	2.5866	.4371	30-32	.9950	3.3051	.6578	24-32	1.1450	4.0799	.9343
5-32	.8475	2.5981	.4403	31-32	.9975	3.3175	.6619	25-32	1.1475	4.0933	.9394
6-32	.8500	2.6096	.4436	12 inches	1.0000	3.3300	.6660	26-32	1.1500	4.1067	.9445
7-32	.8525	2.6211	.4469	1-32	1.0025	3.3425	.6702	27-32	1.1525	4.1201	.9496
8-32	.8550	2.6327	.4502	2-32	1.0050	3.3550	.6744	28-32	1.1550	4.1335	.9548
9-32	.8575	2.6142	.4535	3-32	1.0075	3.3675	.6786	28-32	1.1575	4.1469	.9600
10-32	.8600	2.6558	.4568	4-32	1.0100	3.3801	.6828	29-32	1.1600	4.1604	.9652
11-32	.8625	2.6674	.4601	5-32	1.0125	3.3926	.6870	30-32	1.1625	4.1738	.9704
12-32	.8650	2.6790	.4635	6-32	1.0150	3.4052	.6913	31-32	1.1650	4.1873	.9757
13-32	.8675	2.6906	.4668	7-32	1.0175	3.4178	.6955	14 inches	1.1675	4.2008	.9809
14-32	.8700	2.7022	.4702	8-32	1.0200	3.4304	.6998	1-32	1·1700	4.2143	.9862
15-32	.8725	2.7139	.4736	9-32	1.0225	3.4430	.7041	2-32	1.1725	4.2278	.9914
16-32	.8750	2.7256	.4770	10-32	1.0250	3.4557	.7085	3-32	1.1750	4.2413	.9967
17-32	.8775	2.7373	.4804	11-32	1.0275	3.4683	.7128	4-32	1.1775	4.2548	1.0020
18-32	.8800	2.7490	.4839	12-32	1.0300	3.4810	.7171	5-32	1.1800	4.2684	1.0073
19-32	.8825	2.7607	.4873	12-32	1.0325	3.4937	.7215	6-32	1.1825	4.2820	1.0127
20-32	.8850	2.7724	.4907	13-32	1.0350	3.5063	.7258	7-32	1.1850	4.2956	1.0181
21-32	.8875	2.7841	.4941	14-32	1.0375	3.5191	.7302	8-32	1.1875	4.3092	1.0234
22-32	.8900	2.7959	.4976	15-32	1.0400	3.5318	.7346	9-32	1.1900	4.3228	1.0288
23-32	.8925	2.8077	.5011	16-32	1.0425	3.5445	.7390	10-32	1.1925	4.3364	1.0342
24-32	.8950	2.8195	.5047	17-32	1.0450	3.5573	.7435	11-32	1.1950	4.3501	1.0397
25-32	.8975	2.8313	.5082	18-32	1.0475	3.5700	.7479	12-32	1.1975	4.3637	1.0451
26-32	.9000	2.8432	.5118	19-32	1.0500	3.5828	.7524	13-32	1.2000	4.3774	1.0506
27-32	.9025	2.8550	.5153	20-32	1.0525	3.5956	.7569	14-32	1.2025	4.3911	1.0561
28-32	.9050	2.8669	.5189	21-32	1.0550	3.6085	.7614	15-32	1.2050	4.4048	1.0616
28-32	.9075	2.8788	.5225	22-32	1.0575	3.6213	.7659	16-32	1.2075	4.4185	1.0671
20-32	.9100	2.8907	.5261	23-32	1.0600	3.6342	.7705	17-32	1.2100	4.4322	1.0726
30-32	.9125	2.9026	.5297	21-32	1.0625	3.6470	.7750	18-32	1.2125	4.4459	1.0781
31-32	.9150	2.9146	.5334	25-32	1.0650	3.6599	.7796	19-32	1.2150	4.4597	1.0837
11 inches	.9175	2.9265	.5370	26-32	1.0675	3.6728	.7841	20-32	1.2175	4.4735	1.0893
1-32	.9200	2.9385	.5407	27-32	1.0700	3.6857	.7887	20-32	1.2200	4.4873	1.0949
2-32	.9225	2.9505	.5444	28-32	1.0725	3.6986	.7933	21-32	1.2225	4.5011	1.1005
3-32	.9250	2.9625	.5481	29-32	1.0750	3.7116	.7980	22-32	1.2250	4.5149	1.1061
4-32	.9275	2.9745	.5518	30-32	1.0775	3.7245	.8026	23-32	1.2275	4.5287	1.1118
5-32	.9300	2.9865	.5555	31-32	1.0800	3.7375	.8073	24-32	1.2300	4.5426	1.1175
6-32	.9325	2.9986	.5593	13 inches	1.0825	3.7505	.8120	25-32	1.2325	4.5564	1.1232
7-32	.9350	3.0107	.5630	1-32	1.0850	3.7635	.8167	26-32	1.2350	4.5703	1.1289
8-32	.9375	3.0227	.5667	2-32	1.0875	3.7765	.8214	27-32	1.2375	4.5843	1.1346
9-32	.9400	3.0348	.5705	3-32	1.0900	3.7895	.8261	28-32	1.2400	4.5981	1.1403
10-32	.9425	3.0469	.5743	4-32	1.0925	3.8025	.8308	29-32	1.2425	4.6120	1.1460
11-32	.9450	3.0591	.5782	4-32	1.0950	3.8156	.8356	30-32	1.2450	4.6259	1.1518
12-32	.9475	3.0712	.5820	5-32	1.0975	3.8287	.8404	31-32	1.2475	4.6398	1.1576
13-32	.9500	3.0834	.5858	6-32	1.1000	3.8418	.8452	15 inches	1.2500	4.6538	1.1634
14-32	.9525	3.0956	.5897	7-32	1.1025	3.8549	.8500	1-32	1.2525	4.6678	1.1693
15-32	.9550	3.1078	.5936	8-32	1.1050	3.8680	.8548	2-32	1.2550	4.6818	1.1752
16-32	.9575	3.1200	.5975	9-32	1.1075	3.8811	.8596	3-32	1.2575	4.6958	1.1810
17-32	.9600	3.1322	.6014	10-32	1.1100	3.8943	.8645	4-32	1.2600	4.7098	1.1869

HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
In inches (approximately.)	In feet.			In inches (approximately.)	In feet.			In inches.	In feet.		
5-32	1.2625	4.7238	1.1937	30-32	1.4125	5.5902	1.5792	24-32	1.5625	6.5039	2.0324
6-32	1.2650	4.7378	1.1986	31-32	1.4150	5.6050	1.5862	25-32	1.5650	6.5195	2.0406
7-32	1.2675	4.7519	1.2046	17 inches	1.4175	5.6199	1.5932	26-32	1.5675	6.5351	2.0487
8-32	1.2700	4.7660	1.2106	1-32	1.4200	5.6348	1.6003	27-32	1.5700	6.5508	2.0569
9-32	1.2725	4.7801	1.2166	2-32	1.4225	5.6497	1.6073	28-32	1.5725	6.5664	2.0651
10-32	1.2750	4.7941	1.2225	3-32	1.4250	5.6646	1.6144	29-32	1.5750	6.5821	2.0733
11-32	1.2775	4.8083	1.2286	4-32	1.4275	5.6795	1.6215	30-32	1.5775	6.5978	2.0816
12-32	1.2800	4.8224	1.2346	5-32	1.4300	5.6944	1.6286	31-32	1.5800	6.6135	2.0899
12-32	1.2825	4.8365	1.2406	6-32	1.4325	5.7093	1.6357	19 inches	1.5825	6.6292	2.0981
13-32	1.2850	4.8506	1.2466	7-32	1.4350	5.7243	1.6429	1-32	1.5850	6.6449	2.1064
14-32	1.2975	4.8648	1.2527	8-32	1.4375	5.7392	1.6500	2-32	1.5875	6.6606	2.1147
15-32	1.2900	4.8790	1.2588	9-32	1.4400	5.7542	1.6572	3-32	1.5900	6.6764	2.1231
16-32	1.2925	4.8932	1.2649	10-32	1.4425	5.7692	1.6644	4-32	1.5925	6.6921	2.1314
17-32	1.2950	4.9074	1.2710	11-32	1.4450	5.7842	1.6716	4-32	1.5950	6.7079	2.1398
18-32	1.2975	4.9216	1.2771	12-32	1.4475	5.7992	1.6789	5-32	1.5975	6.7236	2.1482
19-32	1.3000	4.9358	1.2833	13-32	1.4500	5.8143	1.6862	6-32	1.6000	6.7394	2.1566
20-32	1.3025	4.9500	1.2894	14-32	1.4525	5.8293	1.6934	7-32	1.6025	6.7552	2.1650
21-32	1.3050	4.9643	1.2956	15-32	1.4550	5.8444	1.7007	8-32	1.6050	6.7710	2.1735
22-32	1.3075	4.9786	1.3019	16-32	1.4575	5.8594	1.7080	9-32	1.6075	6.7868	2.1819
23-32	1.3100	4.9929	1.3082	17-32	1.4600	5.8745	1.7153	10-32	1.6100	6.8027	2.1904
24-32	1.3125	5.0072	1.3144	18-32	1.4625	5.8896	1.7226	11-32	1.6125	6.8185	2.1989
25-32	1.3150	5.0215	1.3207	19-32	1.4650	5.9047	1.7300	12-32	1.6150	6.8344	2.2075
26-32	1.3175	5.0358	1.3270	20-32	1.4675	5.9198	1.7374	13-32	1.6175	6.8503	2.2160
27-32	1.3200	5.0502	1.3333	20-32	1.4700	5.9350	1.7449	14-32	1.6200	6.8662	2.2246
28-32	1.3225	5.0645	1.3396	21-32	1.4725	5.9501	1.7523	15-32	1.6225	6.8821	2.2332
29-32	1.3250	5.0789	1.3459	22-32	1.4750	5.9653	1.7598	16-32	1.6250	6.8980	2.2418
30-32	1.3275	5.0933	1.3523	23-32	1.4775	5.9805	1.7672	17-32	1.6275	6.9139	2.2505
31-32	1.3300	5.1077	1.3587	24-32	1.4800	5.9957	1.7747	18-32	1.6300	6.9299	2.2592
16 inches	1.3325	5.1221	1.3651	25-32	1.4825	6.0109	1.7822	19-32	1.6325	6.9158	2.2678
1-32	1.3350	5.1365	1.3715	26-32	1.4850	6.0261	1.7898	20-32	1.6350	6.9618	2.2765
2-32	1.3375	5.1509	1.3779	27-32	1.4875	6.0413	1.7973	21-32	1.6375	6.9777	2.2852
3-32	1.3400	5.1654	1.3844	28-32	1.4900	6.0565	1.8048	22-32	1.6400	6.9937	2.2939
4-32	1.3425	5.1798	1.3908	29-32	1.4925	6.0717	1.8124	23-32	1.6425	7.0097	2.3027
4-32	1.3450	5.1943	1.3973	30-32	1.4950	6.0870	1.8200	24-32	1.6450	7.0258	2.3115
5-32	1.3475	5.2088	1.4038	31-32	1.4975	6.1023	1.8276	25-32	1.6475	7.0418	2.3203
6-32	1.3500	5.2233	1.4103	18 inches	1.5000	6.1176	1.8353	26-32	1.6500	7.0578	2.3291
7-32	1.3525	5.2378	1.4168	1-32	1.5025	6.1329	1.8429	27-32	1.6525	7.0738	2.3379
8-32	1.3550	5.2523	1.4233	2-32	1.5050	6.1482	1.8506	28-32	1.6550	7.0899	2.3467
9-32	1.3575	5.2668	1.4299	3-32	1.5075	6.1635	1.8583	28-32	1.6575	7.1060	2.3556
10-32	1.3600	5.2814	1.4365	4-32	1.5100	6.1789	1.8660	29-32	1.6600	7.1221	2.3645
11-32	1.3625	5.2960	1.4431	5-32	1.5125	6.1942	1.8737	30-32	1.6625	7.1382	2.3735
12 32	1.3650	5.3106	1.4498	6-32	1.5150	6.2096	1.8815	31-32	1.6650	7.1543	2.3824
13-32	1.3675	5.3252	1.4564	7-32	1.5175	6.2250	1.8893	20 inches	1.6675	7.1704	2.3913
14-32	1.3700	5.3398	1.4631	8-32	1.5200	6.2404	1.8971	1-32	1.6700	7.1865	2.4003
15-32	1.3725	5.3544	1.4698	9-32	1.5225	6.2558	1.9049	2-32	1.6725	7.2026	2.4093
16-32	1.3750	5.3691	1.4765	10-32	1.5250	6.2712	1.9127	3 32	1.6750	7.2188	2.4183
17-32	1.3775	5.3837	1.4832	11-32	1.5275	6.2866	1.9205	4-32	1.6775	7.2350	2.4273
18-32	1.3800	5.3984	1.4900	12-32	1.5300	6.3020	1.9284	5-32	1.6800	7.2512	2.4364
19-32	1.3825	5.4131	1.4967	12-32	1.5325	6.3174	1.9363	6-32	1.6825	7.2674	2.4455
20-32	1.3850	5.4277	1.5034	13-32	1.5350	6.3329	1.9442	7-32	1.6850	7.2836	2.4546
21-32	1.3875	5.4425	1.5103	14-32	1.5375	6.3484	1.9521	8-32	1.6875	7.2998	2.4637
22-32	1.3900	5.4572	1.5171	15-32	1.5400	6.3639	1.9601	9-32	1.6900	7.3160	2.4728
23-32	1.3925	5.4719	1.5239	16-32	1.5425	6.3794	1.9680	10-32	1.6925	7.3322	2.4819
24-32	1.3950	5.4866	1.5308	17-32	1.5450	6.3949	1.9760	11-32	1.6950	7.3485	2.4911
25-32	1.3975	5.5014	1.5377	18-32	1.5475	6.4104	1.9840	12-32	1.6975	7.3647	2.5003
26-32	1.4000	5.5162	1.5446	19-32	1.5500	6.4260	1.9920	13-32	1.7000	7.3810	2.5095
27-32	1.4025	5.5309	1.5515	20-32	1.5525	6.4415	2.0000	14-32	1.7025	7.3973	2.5187
28-32	1.4050	5.5457	1.5583	21-32	1.5550	6.4571	2.0080	15-32	1.7050	7.4136	2.5280
28-32	1.4075	5.5605	1.5653	22-32	1.5575	6.4727	2.0161	16-32	1.7075	7.4299	2.5373
29-32	1.4100	5.5754	1.5723	23-32	1.5600	6.4883	2.0243	17-32	1.7100	7.4463	2.5467

HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
In inches (approximately.)	In feet.			In inches (approximately.)	In feet.			In inches.	In feet.		
18-32	1.7125	7.4626	2.5559	11-32	1.8625	8.4642	3.1529	5-32	2.0125	9.5071	3.8266
19-32	1.7150	7.4789	2.5652	12-32	1.8650	8.4813	3.1635	6-32	2.0150	9.5248	3.8385
20-32	1.7175	7.4953	2.5746	13-32	1.8675	8.4983	3.1741	7-32	2.0175	9.5425	3.8504
20-32	1.7200	7.5117	2.5840	14-32	1.8700	8.5154	3.1847	8-32	2.0200	9.5603	3.8624
21-32	1.7225	7.5280	2.5934	15-32	1.8725	8.5325	3.1954	9-32	2.0225	9.5780	3.8743
22-32	1.7250	7.5444	2.6028	16-32	1.8750	8.5496	3.2061	10-32	2.0250	9.5958	3.8863
23-32	1.7275	7.5609	2.6123	17-32	1.8775	8.5667	3.2168	11-32	2.0275	9.6136	3.8983
24-32	1.7300	7.5773	2.6217	18-32	1.8800	8.5838	3.2275	12-32	2.0300	9.6314	3.9104
25-32	1.7325	7.5937	2.6312	19-32	1.8825	8.6009	3.2382	12-32	2.0325	9.6492	3.9224
26-32	1.7350	7.6101	2.6407	20-32	1.8850	8.6181	3.2490	13-32	2.0350	9.6670	3.9345
27-32	1.7375	7.6266	2.6502	21-32	1.8875	8.6352	3.2598	14-32	2.0375	9.6848	3.9465
28-32	1.7400	7.6431	2.6598	22-32	1.8900	8.6524	3.2706	15-32	2.0400	9.7026	3.9586
29-32	1.7425	7.6596	2.6694	23-32	1.8925	8.6696	3.2815	16-32	2.0425	9.7204	3.9708
30-32	1.7450	7.6760	2.6789	24-32	1.8950	8.6868	3.2923	17-32	2.0450	9.7383	3.9830
31-32	1.7475	7.6926	2.6886	25-32	1.8975	8.7040	3.3032	18-32	2.0475	9.7562	3.9952
21 inches	1.7500	7.7091	2.6982	26-32	1.9000	8.7212	3.3141	19-32	2.0500	9.7741	4.0074
1-32	1.7525	7.7256	2.7078	27-32	1.9025	8.7384	3.3250	20-32	2.0525	9.7920	4.0196
2-32	1.7550	7.7421	2.7175	28-32	1.9050	8.7556	3.3359	21-32	2.0550	9.8098	4.0318
3-32	1.7575	7.7586	2.7272	28-32	1.9075	8.7728	3.3468	22-32	2.0575	9.8278	4.0442
4-32	1.7600	7.7752	2.7369	29-32	1.9100	8.7901	3.3578	23-32	2.0600	9.8457	4.0565
5-32	1.7625	7.7918	2.7466	30-32	1.9125	8.8073	3.3688	24-32	2.0625	9.8636	4.0688
6-32	1.7650	7.8084	2.7564	31-32	1.9150	8.8246	3.3798	25-32	2.0650	9.8815	4.0811
7-32	1.7675	7.8250	2.7661	23 inches	1.9175	8.8419	3.3908	26-32	2.0675	9.8994	4.0934
8-32	1.7700	7.8416	2.7759	1-32	1.9200	8.8592	3.4019	27-32	2.0700	9.9174	4.1058
9-32	1.7725	7.8582	2.7857	2-32	1.9225	8.8765	3.4130	28-32	2.0725	9.9354	4.1182
10-32	1.7750	7.8748	2.7955	3-32	1.9250	8.8939	3.4242	29-32	2.0750	9.9534	4.1307
11-32	1.7775	7.8914	2.8054	4-32	1.9275	8.9112	3.4353	30-32	2.0775	9.9714	4.1431
12-32	1.7800	7.9081	2.8153	5-32	1.9300	8.9285	3.4464	31-32	2.0800	9.9894	4.1556
12-32	1.7825	7.9248	2.8252	6-32	1.9325	8.9458	3.4575	25 inches	2.0825	10.0074	4.1681
13-32	1.7850	7.9415	2.8351	7-32	1.9350	8.9632	3.4687	1-32	2.0850	10.0254	4.1806
14-32	1.7875	7.9582	2.8450	8-32	1.9375	8.9806	3.4799	2-32	2.0875	10.0434	4.1931
15-32	1.7900	7.9749	2.8550	9-32	1.9400	8.9980	3.4912	3-32	2.0900	10.0615	4.2057
16-32	1.7925	7.9916	2.8650	10-32	1.9425	9.0154	3.5024	4-32	2.0925	10.0795	4.2183
17-32	1.7950	8.0083	2.8750	11-32	1.9450	9.0328	3.5137	4-32	2.0950	10.0976	4.2309
18-32	1.7975	8.0250	2.8850	12-32	1.9475	9.0502	3.5250	5-32	2.0975	10.1157	4.2435
19-32	1.8000	8.0418	2.8950	13-32	1.9500	9.0677	3.5364	6-32	2.1000	10.1338	4.2562
20-32	1.8025	8.0585	2.9051	14-32	1.9525	9.0851	3.5477	7-32	2.1025	10.1519	4.2689
21-32	1.8050	8.0753	2.9152	15-32	1.9550	9.1026	3.5591	8-32	2.1050	10.1700	4.2816
22-32	1.8075	8.0921	2.9253	16-32	1.9575	9.1200	3.5705	9-32	2.1075	10.1881	4.2943
23-32	1.8100	8.1089	2.9354	17-32	1.9600	9.1375	3.5819	10-32	2.1100	10.2063	4.3071
24-32	1.8125	8.1257	2.9455	18-32	1.9625	9.1550	3.5933	11-32	2.1125	10.2244	4.3199
25-32	1.8150	8.1425	2.9557	19-32	1.9650	9.1725	3.6048	12-32	2.1150	10.2426	4.3327
26-32	1.8175	8.1593	2.9659	20-32	1.9675	9.1900	3.6162	13-32	2.1175	10.2607	4.3455
27-32	1.8200	8.1762	2.9762	20-32	1.9700	9.2075	3.6277	14-32	2.1200	10.2789	4.3583
28-32	1.8225	8.1930	2.9864	21-32	1.9725	9.2250	3.6392	15-32	2.1225	10.2971	4.3702
29-32	1.8250	8.2099	2.9966	22-32	1.9750	9.2426	3.6508	16-32	2.1250	10.3153	4.3840
30-32	1.8275	8.2268	3.0069	23-32	1.9775	9.2601	3.6623	17-32	2.1275	10.3335	4.3969
31-32	1.8300	8.2437	3.0172	24-32	1.9800	9.2777	3.6739	18-32	2.1300	10.3518	4.4099
22 inches	1.8325	8.2606	3.0275	25-32	1.9825	9.2953	3.6856	19-32	2.1325	10.3700	4.4228
1-32	1.8350	8.2775	3.0378	26-32	1.9850	9.3129	3.6972	20-32	2.1350	10.3882	4.4357
2-32	1.8375	8.2944	3.0481	27-32	1.9875	9.3305	3.7089	21-32	2.1375	10.4061	4.4487
3-32	1.8400	8.3113	3.0585	28-32	1.9900	9.3481	3.7205	22-32	2.1400	10.4247	4.4617
4-32	1.8425	8.3282	3.0689	29-32	1.9925	9.3657	3.7322	23-32	2.1425	10.4430	4.4748
4-32	1.8450	8.3452	3.0794	30-32	1.9950	9.3834	3.7440	24-32	2.1450	10.4613	4.4879
5-32	1.8475	8.3622	3.0898	31-32	1.9975	9.4010	3.7557	25-32	2.1475	10.4796	4.5010
6-32	1.8500	8.3792	3.1003	24 inches	2.0000	9.4187	3.7675	26-32	2.1500	10.4979	4.5141
7-32	1.8525	8.3962	3.1108	1-32	2.0025	9.4363	3.7793	27-32	2.1525	10.5162	4.5272
8-32	1.8550	8.4132	3.1213	2-32	2.0050	9.4540	3.7911	28-32	2.1550	10.5345	4.5404
9-32	1.8575	8.4302	3.1318	3-32	2.0075	9.4717	3.8029	28-32	2.1575	10.5528	4.5535
10-32	1.8600	8.4172	3.1423	4-32	2.0100	9.4894	3.8147	29-32	2.1600	10.5712	4.5667

HEAD H. In inches (approximately.)	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H. In inches (approximately.)	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H. In inches.	HEAD H. In feet.	Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
30-32	2.1625	10.5895	4.5799	24-32	2.3125	11.7102	5.4160	18-32	2.4625	12.8679	6.3375
31-32	2.1650	10.6079	4.5932	25-32	2.3150	11.7292	5.4306	19-32	2.4650	12.8875	6.3536
26 inches	2.1675	10.6263	4.6065	26-32	2.3175	11.7484	5.4453	20-32	2.4675	12.9071	6.3697
1-32	2.1700	10.6447	4.6198	27-32	2.3200	11.7678	5.4600	20-32	2.4700	12.9267	6.3858
2-32	2.1725	10.6631	4.6331	28-32	2.3225	11.7863	5.4747	21-32	2.4725	12.9463	6.4020
3-32	2.1750	10.6815	4.6464	29-32	2.3250	11.8053	5.4894	22-32	2.4750	12.9660	6.4182
4-32	2.1775	10.6999	4.6598	30-32	2.3275	11.8243	5.5042	23-32	2.4775	12.9856	6.4344
5-32	2.1800	10.7184	4.6732	31-32	2.3300	11.8434	5.5190	24-32	2.4800	13.0053	6.4506
6-32	2.1825	10.7368	4.6866	28 inches	2.3325	11.8625	5.5338	25-32	2.4825	13.0250	6.4669
7-32	2.1850	10.7552	4.7000	1-32	2.3350	11.8816	5.5487	26-32	2.4850	13.0447	6.4832
8-32	2.1875	10.7737	4.7135	2-32	2.3375	11.9007	5.5636	27-32	2.4875	13.0644	6.4995
9-32	2.1900	10.7922	4.7270	3-32	2.3400	11.9198	5.5785	28-32	2.4900	13.0841	6.5159
10-32	2.1925	10.8107	4.7405	4-32	2.3425	11.9389	5.5934	29-32	2.4925	13.1038	6.5322
11-32	2.1950	10.8292	4.7540	4-32	2.3450	11.9580	5.6083	30-32	2.4950	13.1235	6.5486
12-32	2.1975	10.8477	4.7675	5-32	2.3475	11.9771	5.6233	31-32	2.4975	13.1432	6.5650
13-32	2.2000	10.8662	4.7811	6-32	2.3500	11.9963	5.6383	30 inches	2.5000	13.1630	6.5815
14-32	2.2025	10.8847	4.7947	7-32	2.3525	12.0154	5.6533	1-32	2.5025	13.1827	6.5979
15-32	2.2050	10.9033	4.8084	8-32	2.3550	12.0346	5.6683	2-32	2.5050	13.2025	6.6144
16-32	2.2075	10.9218	4.8220	9-32	2.3575	12.0537	5.6838	3-32	2.5075	13.2222	6.6309
17-32	2.2100	10.9404	4.8357	10-32	2.3600	12.0729	5.6984	4-32	2.5100	13.2420	6.6475
18-32	2.2125	10.9589	4.8493	11-32	2.3625	12.0921	5.7135	5-32	2.5125	13.2618	6.6640
19-32	2.2150	10.9775	4.8630	12-32	2.3650	12.1113	5.7286	6-32	2.5150	13.2816	6.6806
20-32	2.2175	10.9961	4.8767	13-32	2.3675	12.1305	5.7437	7-32	2.5175	13.3014	6.6973
20-32	2.2200	11.0147	4.8905	14-32	2.3700	12.1497	5.7589	8-32	2.5200	13.3213	6.7144
21-32	2.2225	11.0333	4.9043	15-32	2.3725	12.1689	5.7741	9-32	2.5225	13.3411	6.7306
22-32	2.2250	11.0519	4.9181	16-32	2.3750	12.1882	5.7894	10-32	2.5250	13.3609	6.7473
23-32	2.2275	11.0705	4.9319	17-32	2.3775	12.2074	5.8046	11-32	2.5275	13.3807	6.7640
24-32	2.2300	11.0892	4.9458	18-32	2.3800	12.2267	5.8199	12-32	2.5300	13.4006	6.7807
25-32	2.2325	11.1078	4.9596	19-32	2.3825	12.2460	5.8352	12-32	2.5325	13.4205	6.7975
26-32	2.2350	11.1265	4.9735	20-32	2.3850	12.2653	5.8506	13-32	2.5350	13.4404	6.8143
27-32	2.2375	11.1452	4.9874	21-32	2.3875	12.2846	5.8659	14-32	2.5375	13.4603	6.8311
28-32	2.2400	11.1639	5.0014	22-32	2.3900	12.3039	5.8813	15-32	2.5400	13.4802	6.8480
29-32	2.2425	11.1826	5.0154	23-32	2.3925	12.3232	5.8967	16-32	2.5425	13.5001	6.8648
30-32	2.2450	11.2013	5.0294	24-32	2.3950	12.3425	5.9121	17-32	2.5450	13.5200	6.8817
31-32	2.2475	11.2200	5.0434	25-32	2.3975	12.3618	5.9275	18-32	2.5475	13.5399	6.8986
27 inches	2.2500	11.2387	5.0574	26-32	2.4000	12.3811	5.9429	19-32	2.5500	13.5598	6.9155
1-32	2.2525	11.2574	5.0715	27-32	2.4025	12.4004	5.9584	20-32	2.5525	13.5797	6.9324
2-32	2.2550	11.2762	5.0856	28-32	2.4050	12.4198	5.9739	21-32	2.5550	13.5997	6.9494
3-32	2.2575	11.2949	5.0997	28-32	2.4075	12.4392	5.9895	22-32	2.5575	13.6197	6.9664
4-32	2.2600	11.3137	5.1138	29-32	2.4100	12.4586	6.0050	23-32	2.5600	13.6397	6.9835
5-32	2.2625	11.3325	5.1279	30-32	2.4125	12.4780	6.0206	24-32	2.5625	13.6597	7.0006
6-32	2.2650	11.3513	5.1421	31-32	2.4150	12.4974	6.0362	25-32	2.5650	13.6797	7.0176
7-32	2.2675	11.3701	5.1563	29 inches	2.4175	12.5168	6.0518	26-32	2.5675	13.6907	7.0348
8-32	2.2700	11.3889	5.1705	1-32	2.4200	12.5362	6.0675	27-32	2.5700	13.7197	7.0519
9-32	2.2725	11.4077	5.1847	2-32	2.4225	12.5556	6.0832	28-32	2.5725	13.7397	7.0691
10-32	2.2750	11.4265	5.1990	3-32	2.4250	12.5751	6.0989	29-32	2.5750	13.7597	7.0863
11-32	2.2775	11.4454	5.2133	4-32	2.4275	12.5945	6.1146	30-32	2.5775	13.7797	7.1035
12-32	2.2800	11.4643	5.2277	5-32	2.4300	12.6140	6.1304	31-32	2.5800	13.7998	7.1207
12-32	2.2825	11.4831	5.2420	6-32	2.4325	12.6335	6.1462	31 inches	2.5825	13.8199	7.1380
13-32	2.2850	11.5020	5.2564	7-32	2.4350	12.6529	6.1619	1-32	2.5850	13.8400	7.1553
14-32	2.2875	11.5209	5.2708	8-32	2.4375	12.6724	6.1777	2-32	2.5875	13.8600	7.1726
15-32	2.2900	11.5398	5.2853	9-32	2.4400	12.6919	6.1936	3-32	2.5900	13.8801	7.1899
16-32	2.2925	11.5587	5.2997	10-32	2.4425	12.7114	6.2095	4-32	2.5925	13.9002	7.2072
17-32	2.2950	11.5776	5.3141	11-32	2.4450	12.7310	6.2255	4-32	2.5950	13.9203	7.2246
18-32	2.2975	11.5965	5.3285	12-32	2.4475	12.7505	6.2414	5-32	2.5975	13.9404	7.2420
19-32	2.3000	11.6154	5.3430	13-32	2.4500	12.7701	6.2574	6-32	2.6000	13.9606	7.2595
20-32	2.3025	11.6343	5.3576	14-32	2.4525	12.7896	6.2734	7-32	2.6025	13.9807	7.2770
21-32	2.3050	11.6533	5.3722	15-32	2.4550	12.8092	6.2894	8-32	2.6050	14.0009	7.2945
22-32	2.3075	11.6723	5.3868	16-32	2.4575	12.8287	6.3054	9-32	2.6075	14.0210	7.3120
23-32	2.3100	11.6913	5.4014	17-32	2.4600	12.8483	6.3214	10-32	2.6100	14.0412	7.3292

HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.	HEAD H.		Discharge in cubic feet per second.	Correction to be subtracted to give discharge with two complete end contractions.
In inches (approximately.)	In feet.			In inches (approximately.)	In feet.			In inches.	In feet.		
11-32	2.6125	14.0614	7.3471	29-32	2.7425	15.1239	8.2954	15-32	2.8725	16.2119	9.3137
12-32	2.6150	14.0816	7.3647	30-32	2.7450	15.1446	8.3144	16-32	2.8750	16.2331	9.3340
13-32	2.6175	14.1018	7.3823	31-32	2.7475	15.1653	8.3333	17-32	2.8775	16.2542	9.3543
14-32	2.6200	14.1220	7.3999	33 inches	2.7500	15.1860	8.3523	18-32	2.8800	16.2754	9.3746
15-32	2.6225	14.1422	7.4175	1-32	2.7525	15.2067	8.3713	19-32	2.8825	16.2966	9.3950
16-32	2.6250	14.1624	7.4352	2-32	2.7550	15.2274	8.3903	20-32	2.8850	16.3178	9.4154
17-32	2.6275	14.1826	7.4529	3-32	2.7575	15.2481	8.4093	21-32	2.8875	16.3391	9.4359
18-32	2.6300	14.2029	7.4707	4-32	2.7600	15.2689	8.4284	22-32	2.8900	16.3603	9.4563
19-32	2.6325	14.2231	7.4884	5-32	2.7625	15.2896	8.4474	23-32	2.8925	16.3815	9.4768
20-32	2.6350	14.2434	7.5062	6-32	2.7650	15.3104	8.4665	24-32	2.8950	16.4028	9.4973
21-32	2.6375	14.2637	7.5240	7-32	2.7675	15.3312	8.4857	25-32	2.8975	16.4240	9.5178
22-32	2.6400	14.2840	7.5419	8-32	2.7700	15.3520	8.5050	26-32	2.9000	16.4453	9.5383
23-32	2.6425	14.3043	7.5598	9-32	2.7725	15.3728	8.5242	27-32	2.9025	16.4665	9.5588
24-32	2.6450	14.3246	7.5777	10-32	2.7750	15.3935	8.5434	28-32	2.9050	16.4878	9.5794
25-32	2.6475	14.3449	7.5956	11-32	2.7775	15.4144	8.5627	28-32	2.9075	16.5091	9.6000
26-32	2.6500	14.3652	7.6135	12-32	2.7800	15.4352	8.5820	29-32	2.9100	16.5304	9.6207
27-32	2.6525	14.3855	7.6315	12-32	2.7825	15.4560	8.6013	30-32	2.9125	16.5517	9.6413
28-32	2.6550	14.4059	7.6495	13-32	2.7850	15.4768	8.6206	31-32	2.9150	16.5730	9.6620
28-32	2.6575	14.4263	7.6676	14-32	2.7875	15.4976	8.6399	35 inches	2.9175	16.5943	9.6628
29-32	2.6600	14.4467	7.6857	15-32	2.7900	15.5185	8.6593	1-32	2.9200	16.6157	9.7036
30-32	2.6625	14.4670	7.7037	16-32	2.7925	15.5394	8.6787	2-32	2.9225	16.6370	9.7244
31-32	2.6650	14.4874	7.7218	17-32	2.7950	15.5603	8.6982	3-32	2.9250	16.6584	9.7452
32 inches	2.6675	14.5077	7.7399	18-32	2.7975	15.5811	8.7176	4-32	2.9275	16.6797	9.7660
1-32	2.6700	14.5281	7.7580	19-32	2.8000	15.6020	8.7371	5-32	2.9300	16.7011	9.7868
2-32	2.6725	14.5485	7.7762	20-32	2.8025	15.6229	8.7567	6-32	2.9325	16.7225	9.8077
3-32	2.6750	14.5690	7.7944	21-32	2.8050	15.6438	8.7762	7-32	2.9350	16.7439	9.8287
4-32	2.6775	14.5894	7.8126	22-32	2.8075	15.6647	8.7958	8-32	2.9375	16.7653	9.8496
5-32	2.6800	14.6099	7.8309	23-32	2.8100	15.6857	8.8154	9-32	2.9400	16.7867	9.8707
6-32	2.6825	14.6303	7.8492	24-32	2.8125	15.7066	8.8350	10-32	2.9425	16.8081	9.8916
7-32	2.6850	14.6508	7.8675	25-32	2.8150	15.7276	8.8547	11-32	2.9450	16.8295	9.9126
8-32	2.6875	14.6712	7.8858	26-32	2.8175	15.7485	8.8743	12-32	2.9475	16.8509	9.9336
9-32	2.6900	14.6917	7.9041	27-32	2.8200	15.7695	8.8940	13-32	2.9500	16.8724	9.9547
10-32	2.6925	14.7122	7.9225	28-32	2.8225	15.7904	8.9137	14-32	2.9525	16.8938	9.9758
11-32	2.6950	14.7327	7.9409	29-32	2.8250	15.8114	8.9334	15-32	2.9550	16.9153	9.9970
12-32	2.6975	14.7532	7.9593	30-32	2.8275	15.8324	8.9532	16-32	2.9575	16.9368	10.0181
13-32	2.7000	14.7737	7.9778	31-32	2.8500	15.8534	8.9730	17-32	2.9600	16.9583	10.0393
14-32	2.7025	14.7942	7.9963	34 inches	2.8325	15.8744	8.9928	18-32	2.9625	16.9798	10.0605
15-32	2.7050	14.8147	8.0147	1-32	2.8350	15.8954	9.0127	19-32	2.9650	17.0013	10.0818
16-32	2.7075	14.8352	8.0332	2-32	2.8375	15.9164	9.0326	20-32	2.9675	17.0228	10.1030
17-32	2.7100	14.8558	8.0518	3-32	2.8400	15.9375	9.0525	20-32	2.9700	17.0443	10.1243
18-32	2.7125	14.8764	8.0704	4-32	2.8425	15.9585	9.0724	21-32	2.9725	17.0658	10.1456
19-32	2.7150	14.8970	8.0891	4-32	2.8450	15.9796	9.0924	22-32	2.9750	17.0873	10.1669
20-32	2.7175	14.9176	8.1077	5-32	2.8475	16.0007	9.1124	23-32	2.9775	17.1088	10.1883
20-32	2.7200	14.9382	8.1264	6-32	2.8500	16.0218	9.1324	24-32	2.9800	17.1304	10.2097
21-32	2.7225	14.9588	8.1451	7-32	2.8525	16.0429	9.1525	25-32	2.9825	17.1520	10.2312
22-32	2.7250	14.9794	8.1638	8-32	2.8550	16.0640	9.1726	26-32	2.9850	17.1735	10.2526
23-32	2.7275	15.0000	8.1825	9-32	2.8575	16.0851	9.1926	27-32	2.9875	17.1951	10.2741
24-32	2.7300	15.0206	8.2012	10-32	2.8600	16.1062	9.2127	28-32	2.9900	17.2167	10.2956
25-32	2.7325	15.0412	8.2200	11-32	2.8625	16.1273	9.2328	29-32	2.9925	17.2383	10.3171
26-32	2.7350	15.0619	8.2389	12-32	2.8650	16.1484	9.2530	30-32	2.9950	17.2599	10.3387
27-32	2.7375	15.0825	8.2577	13-32	2.8675	16.1695	9.2732	31-32	2.9975	17.2815	10.3603
28-32	2.7400	15.1032	8.2766	14-32	2.8700	16.1907	9.2934	36 inches	3 feet	17.3032	10.3819

TABLE IV.

Formula, $Q=3.33\,(L-.2H)\,H^{\frac{3}{2}}$

For conditions, see page 17.

Discharge over Rectangular Weirs, with Complete Contractions.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.														HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	1 Foot Long.	1½ Feet Long.	2 Feet Long.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
1-16	.005	.0012	.0018	.0024	.0030	.0036	.0048	.0060	.0072	.0084	.0096	.0108	.0120	.0132	.0144	.005	1-16
2-16	.010	.0033	.0050	.0066	.0082	.0099	.0132	.0165	.0198	.0231	.0264	.0297	.0330	.0363	.0396	.010	2-16
3-16	.015	.0061	.0091	.0122	.0152	.0183	.0244	.0305	.0366	.0427	.0488	.0549	.0610	.0671	.0782	.015	3-16
4-16	.020	.0094	.0141	.0188	.0235	.0282	.0376	.0470	.0564	.0358	.0752	.0846	.0940	.1034	.1128	.020	4-16
5-16	.025	.0131	.0197	.0263	.0329	.0395	.0527	.0659	.0791	.0923	.1055	.1187	.1319	.1451	.1583	.025	5-16
6-16	.030	.0172	.0258	.0345	.0431	.0518	.0691	.0864	.1037	.1210	.1383	.1556	.1729	.1902	.2075	.030	6-16
7-16	.035	.0217	.0326	.0435	.0544	.0653	.0871	.1089	.1307	.1525	.1743	.1961	.2179	.2397	.2615	.035	7-16
8-16	.040	.0264	.0397	.0530	.0663	.0796	.1062	.1328	.1594	.1860	.2126	.2392	.2658	.2924	.3190	.040	8-16
8-16	.045	.0315	.0474	.0633	.0792	.0951	.1269	.1587	.1905	.2223	.2541	.2859	.3177	.3495	.3813	.045	8-16
9-16	.050	.0368	.0554	.0740	.0926	.1112	.1484	.1856	.2228	.2600	.2972	.3344	.3716	.4088	.4460	.050	9-16
10-16	.055	.0425	.0640	.0855	.1070	.1285	.1715	.2145	.2575	.3005	.3435	.3865	.4295	.4725	.5155	.055	10-16
11-16	.060	.0483	.0727	.0972	.1216	.1461	.1950	.2439	.2928	.3417	.3906	.4395	.4884	.5373	.5862	.060	11-16
12-16	.065	.0545	.0821	.1097	.1373	.1649	.2201	.2753	.3305	.3857	.4409	.4961	.5513	.6065	.6617	.065	12-16
13-16	.070	.0608	.0916	.1225	.1533	.1842	.2459	.3076	.3693	.4310	.4927	.5544	.6161	.6778	.7395	.070	13-16
14-16	.075	.0674	.1016	.1358	.1700	.2042	.2726	.3410	.4094	.4778	.5462	.6146	.6830	.7514	.8198	.075	14-16
15-16	.080	.0741	.1117	.1494	.1870	.2247	.3000	.3753	.4506	.5259	.6012	.6765	.7518	.8271	.9024	.080	15-16
1 inch	.085	.0811	.1223	.1636	.2048	.2461	.3286	.4111	.4936	.5761	.6586	.7411	.8236	.9061	.9886	.085	1 inch
1-16	.090	.0883	.1332	.1782	.2231	.2681	.3580	.4479	.5378	.6277	.7176	.8075	.8974	.9873	1.0772	.090	1-16
2-16	.095	.0957	.1444	.1932	.2419	.2907	.3882	.4857	.5832	.6807	.7782	.8757	.9732	1.0707	1.1682	.095	2-16
3-16	.100	.1032	.1558	.2085	.2611	.3138	.4191	.5244	.6297	.7350	.8403	.9456	1.0509	1.1562	1.2615	.100	3-16
4-16	.105	.1109	.1677	.2244	.2811	.3378	.4512	.5646	.6780	.7914	.9048	1.0182	1.1316	1.2450	1.3584	.105	4-16
5-16	.110	.1188	.1795	.2403	.3010	.3618	.4833	.6048	.7263	.8478	.9693	1.0908	1.2123	1.3338	1.4553	.110	5-16
6-16	.115	.1269	.1918	.2568	.3217	.3867	.5166	.6465	.7764	.9063	1.0362	1.1661	1.2960	1.4259	1.5558	.115	6-16
7-16	.120	.1351	.2043	.2735	.3427	.4119	.5503	.6887	.8271	.9655	1.1039	1.2423	1.3807	1.5191	1.6575	.120	7-16
8-16	.125	.1435	.2171	.2907	.3643	.4379	.5851	.7323	.8795	1.0267	1.1739	1.3211	1.4683	1.6155	1.7627	.125	8-16
9-16	.130	.1520	.2300	.3081	.3861	.4642	.6203	.7764	.9325	1.0886	1.2447	1.4008	1.5569	1.7130	1.8691	.130	9-16
10-16	.135	.1607	.2433	.3259	.4085	.4911	.6563	.8215	.9867	1.1519	1.3171	1.4823	1.6475	1.8127	1.9779	.135	10-16
11-16	.140	.1696	.2568	.3440	.4312	.5184	.6928	.8672	1.0416	1.2160	1.3904	1.5648	1.7392	1.9130	2.0880	.140	11-16
12-16	.145	.1786	.2705	.3625	.4544	.5464	.7303	.9142	1.0982	1.2821	1.4660	1.6499	1.8338	2.0177	2.2016	.145	12-16
13-16	.150	.1877	.2844	.3811	.4778	.5745	.7679	.9613	1.1547	1.3481	1.5415	1.7349	1.9283	2.1217	2.3151	.150	13-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.														HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	1 Foot Long.	1½ Feet Long.	2 Feet Long.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
14-16	.155	.1969	.2985	.4001	.5017	.6033	.8065	1.0097	1.2129	1.4161	1.6193	1.8225	2.0257	2.2289	2.4321	.155	14-16
15-16	.160	.2063	.3128	.4194	.5259	.6325	.8456	1.0587	1.2718	1.4849	1.6980	1.9111	2.1242	2.3373	2.5504	.160	15-16
2 inches	.165	.2158	.3274	.4390	.5506	.6622	.8854	1.1086	1.3318	1.5550	1.7782	2.0014	2.2246	2.4478	2.6710	.165	2 inches
2 inches	.170	.2255	.3422	.4589	.5756	.6923	.9257	1.1591	1.3925	1.6259	1.8593	2.0927	2.3261	2.5595	2.7929	.170	2 inches
1-16	.175	.2352	.3571	.4790	.6009	.7228	.9666	1.2104	1.4542	1.6980	1.9418	2.1856	2.4294	2.6732	2.9170	.175	1-16
2-16	.180	.2452	.3723	.4995	.6266	.7538	1.0081	1.2624	1.5167	1.7710	2.0253	2.2796	2.5339	2.7882	3.0425	.180	2-16
3-16	.185	.2552	.3877	.5202	.6527	.7852	1.0502	1.3152	1.5802	1.8452	2.1102	2.3752	2.6402	2.9052	3.1702	.185	3-16
4-16	.190	.2653	.4032	.5411	.6790	.8169	1.0927	1.3685	1.6443	1.9201	2.1959	2.4717	2.7475	3.0233	3.2991	.190	4-16
5-16	.195	.2756	.4189	.5623	.7056	.8490	1.1357	1.4224	1.7091	1.9958	2.2825	2.5692	2.8559	3.1426	3.4293	.195	5-16
6-16	.200	.2859	.4348	.5837	.7326	.8815	1.1793	1.4771	1.7749	2.0727	2.3705	2.6683	2.9661	3.2639	3.5617	.200	6-16
7-16	.205	.2964	.4509	.6055	.7600	.9146	1.2237	1.5328	1.8419	2.1510	2.4601	2.7692	3.0783	3.3874	3.6965	.205	7-16
8-16	.210	.3070	.4672	.6275	.7877	.9480	1.2685	1.5890	1.9095	2.2300	2.5505	2.8710	3.1915	3.5120	3.8325	.210	8-16
9-16	.215	.3177	.4837	.6497	.8157	.9817	1.3137	1.6457	1.9777	2.3097	2.6417	2.9737	3.3057	3.6377	3.9697	.215	9-16
10-16	.220	.3285	.5003	.6721	.8439	1.0157	1.3593	1.7029	2.0465	2.3901	2.7337	3.0773	3.4209	3.7645	4.1081	.220	10-16
11-16	.225	.3394	.5171	.6948	.8725	1.0502	1.4056	1.7610	2.1164	2.4718	2.8272	3.1826	3.5380	3.8934	4.2488	.225	11-16
12-16	.230	.3504	.5340	.7177	.9013	1.0850	1.4523	1.8196	2.1869	2.5542	2.9215	3.2888	3.6561	4.0234	4.3907	.230	12-16
13-16	.235	.3615	.5512	.7409	.9306	1.1230	1.4997	1.8791	2.2585	2.6379	3.0173	3.3967	3.7761	4.1555	4.5349	.235	13-16
14-16	.240	.3727	.5684	.7642	.9599	1.1557	1.5472	1.9387	2.3302	2.7217	3.1132	3.5047	3.8962	4.2877	4.6792	.240	14-16
15-16	.245	.3840	.5859	.7878	.9897	1.1916	1.5954	1.9992	2.4030	2.8068	3.2106	3.6144	4.0182	4.4220	4.8258	.245	15-16
3 inches	.250	.3954	.6035	.8116	1.0197	1.2278	1.6440	2.0602	2.4764	2.8926	3.3088	3.7250	4.1412	4.5574	4.9736	.250	3 inches
1-16	.255	.4069	.6213	.8357	1.0501	1.2645	1.6933	2.1221	2.5509	2.9797	3.4085	3.8373	4.2661	4.6949	5.1237	.255	1-16
2-16	.260	.4185	.6392	.8600	1.0807	1.3015	1.7430	2.1845	2.6260	3.0675	3.5090	3.9505	4.3920	4.8335	5.2750	.260	2-16
3-16	.265	.4302	.6573	.8845	1.1116	1.3388	1.7931	2.2474	2.7017	3.1560	3.6103	4.0646	4.5189	4.9732	5.4275	.265	3-16
4-16	.270	.4420	.6756	.9092	1.1428	1.3764	1.8436	2.3108	2.7780	3.2452	3.7124	4.1796	4.6468	5.1140	5.5812	.270	4-16
5-16	.275	.4538	.6939	.9340	1.1741	1.4142	1.8944	2.3746	2.8548	3.3350	3.8152	4.2954	4.7756	5.2558	5.7360	.275	5-16
6-16	.280	.4658	.7125	.9592	1.2059	1.4526	1.9460	2.4394	2.9328	3.4262	3.9196	4.4130	4.9064	5.3998	5.8932	.280	6-16
7-16	.285	.4778	.7311	.9845	1.2378	1.4912	1.9979	2.5046	3.0113	3.5180	4.0247	4.5314	5.0381	5.5448	6.0515	.285	7-16
8-16	.290	.4899	.7499	1.0099	1.2699	1.5299	2.0499	2.5699	3.0899	3.6099	4.1299	4.6499	5.1699	5.6899	6.2099	.290	8-16
8-16	.295	.5021	.7689	1.0357	1.3025	1.5693	2.1029	2.6365	3.1701	3.7037	4.2372	4.7709	5.3045	5.8381	6.3717	.295	8-16
9-16	.300	.5143	.7879	1.0615	1.3351	1.6087	2.1559	2.7031	3.2503	3.7975	4.3447	4.8919	5.4391	5.9863	6.5335	.300	9-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.														HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	1 Foot Long.	1½ Feet Long.	2 Feet Long.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
10-16	.305	.5267	.8071	1.0876	1.3680	1.6485	2.2094	2.7703	3.3312	3.8921	4.4530	5.0139	5.5748	6.1357	6.6966	.305	10-16
11-16	.310	.5391	.8265	1.1139	1.4013	1.6887	2.2635	2.8383	3.4131	3.9879	4.5627	5.1375	5.7123	6.2871	6.8619	.310	11-16
12-16	.315	.5516	.8459	1.1403	1.4345	1.7290	2.3177	2.9064	3.4951	4.0838	4.6725	5.2612	5.8499	6.4386	7.0273	.315	12-16
13-16	.320	.5642	.8655	1.1670	1.4684	1.7698	2.3726	2.9754	3.5782	4.1810	4.7838	5.3866	5.9894	6.5922	7.1950	.320	13-16
14-16	.325	.5769	.8854	1.1939	1.5024	1.8109	2.4279	3.0449	3.6619	4.2789	4.8959	5.5129	6.1299	6.7469	7.3639	.325	14-16
15-16	.330	.5896	.9052	1.2209	1.5365	1.8522	2.4835	3.1148	3.7461	4.3774	5.0087	5.6400	6.2713	6.9026	7.5339	.330	15-16
4 inches	.335	.6021	.9252	1.2481	1.5709	1.8938	2.5395	3.1852	3.8309	4.4766	5.1223	5.7680	6.4137	7.0594	7.7051	.335	4 inches
1-16	.340	.6153	.9454	1.2755	1.6056	1.9357	2.5959	3.2561	3.9163	4.5765	5.2367	5.8969	6.5571	7.2173	7.8775	.340	1-16
2-16	.345	.6282	.9656	1.3031	1.6401	1.9778	2.6526	3.3274	4.0024	4.6770	5.3518	6.0266	6.7014	7.3762	8.0510	.345	2-16
3-16	.350	.6413	.9860	1.3308	1.6756	2.0203	2.7098	3.3993	4.0888	4.7783	5.4678	6.1573	6.8468	7.5363	8.2258	.350	3-16
4-16	.355	.6543	1.0064	1.3586	1.7107	2.0629	2.7672	3.4715	4.1758	4.8801	5.5844	6.2887	6.9930	7.6973	8.4016	.355	4-16
5-16	.360	.6675	1.0271	1.3868	1.7464	2.1061	2.8254	3.5447	4.2640	4.9833	5.7026	6.4219	7.1412	7.8605	8.5798	.360	5-16
6-16	.365	.6807	1.0478	1.4150	1.7821	2.1493	2.8836	3.6179	4.3522	5.0865	5.8208	6.5551	7.2894	8.0237	8.7580	.365	6-16
7-16	.370	.6940	1.0687	1.4435	1.8183	2.1930	2.9425	3.6920	4.4415	5.1910	5.9405	6.6900	7.4395	8.1890	8.9385	.370	7-16
8-16	.375	.7073	1.0896	1.4720	1.8543	2.2367	3.0014	3.7661	4.5308	5.2955	6.0602	6.8249	7.5896	8.3543	9.1190	.375	8-16
9-16	.380	.7208	1.1108	1.5008	1.8908	2.2808	3.0608	3.8408	4.6208	5.4008	6.1808	6.9608	7.7408	8.5208	9.3008	.380	9-16
10-16	.385	.7342	1.1319	1.5297	1.9275	2.3252	3.1207	3.9162	4.7117	5.5072	6.3027	7.0982	7.8937	8.6892	9.4847	.385	10-16
11-16	.390	.7478	1.1533	1.5588	1.9643	2.3698	3.1808	3.9918	4.8028	5.6138	6.4248	7.2358	8.0468	8.8578	9.6688	.390	11-16
12-16	.395	.7614	1.1747	1.5881	2.0014	2.4148	3.2415	4.0682	4.8949	5.7216	6.5483	7.3750	8.2017	9.0284	9.8551	.395	12-16
13-16	.400	.7750	1.1962	1.6174	2.0386	2.4598	3.3022	4.1446	4.9870	5.8294	6.6718	7.5142	8.3566	9.1990	10.0414	.400	13-16
14-16	.405	.7887	1.2178	1.6470	2.0761	2.5053	3.3636	4.2219	5.0802	5.9385	6.7968	7.6551	8.5134	9.3717	10.2300	.405	14-16
15-16	.410	.8025	1.2396	1.6767	2.1138	2.5509	3.4251	4.2993	5.1735	6.0477	6.9219	7.7961	8.6703	9.5445	10.4187	.410	15-16
5 inches	.415	.8164	1.2615	1.7067	2.1518	2.5970	3.4873	4.3776	5.2679	6.1582	7.0485	7.9388	8.8291	9.7194	10.6097	.415	5 inches
5 inches	.420	.8303	1.2835	1.7367	2.1899	2.6431	3.5495	4.4559	5.3623	6.2687	7.1751	8.0815	8.9879	9.8943	10.8007	.420	5 inches
1-16	.425	.8442	1.3055	1.7668	2.2281	2.6894	3.6120	4.5346	5.4572	6.3798	7.3024	8.2250	9.1476	10.0702	10.9928	.425	1-16
2-16	.430	.8582	1.3277	1.7972	2.2667	2.7362	3.6752	4.6142	5.5532	6.4922	7.4312	8.3702	9.3092	10.2482	11.1872	.430	2-16
3-16	.435	.8723	1.3500	1.8277	2.3054	2.7831	3.7385	4.6939	5.6493	6.6047	7.5601	8.5155	9.4709	10.4263	11.3817	.435	3-16
4-16	.440	.8864	1.3723	1.8583	2.3442	2.8302	3.8021	4.7740	5.7459	6.7178	7.6897	8.6616	9.6335	10.6054	11.5773	.440	4-16
5-16	.445	.9005	1.3947	1.8890	2.3832	2.8775	3.8660	4.8545	5.8430	6.8315	7.8200	8.8085	9.7970	10.7855	11.7740	.445	5-16
6-16	.450	.9148	1.4174	1.9200	2.4226	2.9252	3.9304	4.9356	5.9408	6.9460	7.9513	8.9564	9.9616	10.9668	11.9720	.450	6-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.													HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	1½ Feet Long.	2 Feet Long.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
7-16	.455	1.4400	1.9510	2.4620	2.9730	3.9950	5.0170	6.0390	7.0610	8.0830	9.1050	10.1270	11.1490	12.1710	.455	7-16
8-16	.460	1.4627	1.9822	2.5016	3.0211	4.0600	5.0989	6.1378	7.1767	8.2156	9.2545	10.2934	11.3323	12.3712	.460	8-16
9-16	.465	1.4856	2.0136	2.5414	3.0695	4.1254	5.1813	6.2372	7.2931	8.3490	9.4049	10.4608	11.5167	12.5726	.465	9-16
10-16	.470	1.5086	2.0451	2.5816	3.1181	4.1911	5.2641	6.3371	7.4101	8.4831	9.5561	10.6291	11.7021	12.7751	.470	10-16
11-16	.475	1.5316	2.0767	2.6217	3.1668	4.2569	5.3470	6.4371	7.5272	8.6173	9.7074	10.7975	11.8876	12.9777	.475	11-16
12-16	.480	1.5548	2.1085	2.6622	3.2159	4.3233	5.4307	6.5381	7.6455	8.7529	9.8603	10.9677	12.0751	13.1825	.480	12-16
13-16	.485	1.5781	2.1405	2.7029	3.2653	4.3901	5.5149	6.6397	7.7645	8.8893	10.0141	11.1389	12.2637	13.3885	.485	13-16
14-16	.490	1.6014	2.1725	2.7436	3.3147	4.4569	5.5991	6.7413	7.8835	9.0257	10.1679	11.3101	12.4523	13.5945	.490	14-16
15-16	.495	1.6247	2.2046	2.7844	3.3643	4.5240	5.6837	6.8434	8.0031	9.1628	10.3225	11.4822	12.6419	13.8016	.495	15-16
6 inches	.500	1.6482	2.2369	2.8255	3.4142	4.5915	5.7688	6.9461	8.1234	9.3007	10.4780	11.6553	12.8326	14.0099	.500	6 inches
1-16	.505	1.6718	2.2693	2.8668	3.4643	4.6593	5.8543	7.0493	8.2443	9.4393	10.6343	11.8293	13.0243	14.2193	.505	1-16
2-16	.510	1.6955	2.3019	2.9083	3.5147	4.7275	5.9403	7.1531	8.3659	9.5787	10.7915	12.0043	13.2171	14.4299	.510	2-16
3-16	.515	1.7192	2.3346	2.9499	3.5653	4.7960	6.0267	7.2574	8.4881	9.7188	10.9495	12.1802	13.4109	14.6416	.515	3-16
4-16	.520	1.7431	2.3675	2.9918	3.6162	4.8649	6.1136	7.3623	8.6110	9.8597	11.1084	12.3571	13.6058	14.8545	.520	4-16
5-16	.525	1.7670	2.4004	3.0337	3.6671	4.9338	6.2005	7.4672	8.7339	10.0006	11.2673	12.5340	13.8007	15.0674	.525	5-16
6-16	.530	1.7911	2.4336	3.0760	3.7185	5.0034	6.2883	7.5732	8.8581	10.1430	11.4279	12.7128	13.9977	15.2826	.530	6-16
7-16	.535	1.8152	2.4668	3.1183	3.7699	5.0730	6.3761	7.6792	8.9823	10.2854	11.5885	12.8916	14.1947	15.4978	.535	7-16
8-16	.540	1.8394	2.5001	3.1608	3.8215	5.1429	6.4643	7.7857	9.1071	10.4285	11.7499	13.0713	14.3927	15.7141	.540	8-16
8-16	.545	1.8637	2.5336	3.2035	3.8734	5.2132	6.5530	7.8928	9.2326	10.5724	11.9122	13.2520	14.5918	15.9316	.545	8-16
9-16	.550	1.8880	2.5672	3.2463	3.9255	5.2838	6.6421	8.0004	9.3587	10.7170	12.0753	13.4336	14.7919	16.1502	.550	9-16
10-16	.555	1.9124	2.6008	3.2892	3.9776	5.3544	6.7312	8.1080	9.4848	10.8616	12.2384	13.6152	14.9920	16.3688	.555	10-16
11-16	.560	1.9369	2.6347	3.3324	4.0302	5.4257	6.8212	8.2167	9.6122	11.0077	12.4032	13.7987	15.1942	16.5897	.560	11-16
12-16	.565	1.9615	2.6686	3.3757	4.0828	5.4970	6.9112	8.3254	9.7396	11.1538	12.5680	13.9822	15.3964	16.8106	.565	12-16
13-16	.570	1.9862	2.7027	3.4192	4.1357	5.5687	7.0017	8.4347	9.8677	11.3007	12.7337	14.1667	15.5997	17.0327	.570	13-16
14-16	.575	2.0109	2.7369	3.4628	4.1888	5.6407	7.0926	8.5445	9.9964	11.4483	12.9002	14.3521	15.8040	17.2559	.575	14-16
15-16	.580	2.0357	2.7712	3.5066	4.2421	5.7130	7.1839	8.6548	10.1257	11.5966	13.0675	14.5384	16.0093	17.4802	.580	15-16
7 inches	.585	2.0606	2.8056	3.5506	4.2956	5.7856	7.2756	8.7656	10.2556	11.7456	13.2356	14.7256	16.2156	17.7056	.585	7 inches
1-16	.590	2.0855	2.8401	3.5946	4.3492	5.8583	7.3674	8.8765	10.3856	11.8947	13.4038	14.9129	16.4220	17.9311	.590	1-16
2-16	.595	2.1105	2.8747	3.6388	4.4030	5.9313	7.4596	8.9879	10.5162	12.0445	13.5728	15.1011	16.6294	18.1577	.595	2-16
3-16	.600	2.1357	2.9095	3.6833	4.4571	6.0047	7.5523	9.0999	10.6475	12.1951	13.7427	15.2903	16.8379	18.3855	.600	3-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.												HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	2 Feet Long.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
4-16	.605	2.9444	3.7279	4.5114	6.0784	7.6454	9.2124	10.7794	12.3464	13.9134	15.4804	17.0474	18.6144	.605	4-16
5-16	.610	2.9794	3.7726	4.5659	6.1524	7.7389	9.3254	10.9119	12.4984	14.0849	15.6714	17.2579	18.8444	.610	5-16
6-16	.615	3.0145	3.8173	4.6205	6.2265	7.8325	9.4385	11.0445	12.6505	14.2565	15.8625	17.4685	19.0745	.615	6-16
7-16	.620	3.0498	3.86[illegible]6	4.6755	6.3012	7.9269	9.5526	11.1783	12.8040	14.4297	16.0554	17.6811	19.3068	.620	7-16
8-16	.625	3.0851	3.9078	4.7305	6.3759	8.0213	9.6667	11.3121	12.9575	14.6029	16.2483	17.8937	19.5391	.625	8-16
9-16	.630	3.1205	3.9531	4.7857	6.4509	8.1161	9.7813	11.4465	13.1117	14.7769	16.4421	18.1073	19.7725	.630	9-16
10-16	.635	3.1560	3.9985	4.8410	6.5260	8.2110	9.8960	11.5810	13.2660	14.9510	16.6360	18.3210	20.0060	.635	10-16
11-16	.640	3.1918	4.0443	4.8968	6.6018	8.3068	10.0118	11.7168	13.4218	15.1268	16.8318	18.5368	20.2418	.640	11-16
12-16	.645	3.2275	4.09[illegible]0	4.9525	6.6775	8.4025	10.1275	11.8525	13.5775	15.3025	17.0275	18.7525	20.4775	.645	12-16
13-16	.650	3.2633	4.1358	5.0084	6.7535	8.4986	10.2437	11.9888	13.7339	15.4790	17.2241	18.9692	20.7143	.650	13-16
14-16	.655	3.2992	4.1818	5.0644	6.8296	8.5948	10.3600	12.1252	13.8904	15.6556	17.4208	19.1860	20.9512	.655	14-16
15-16	.660	3.3353	4.2280	5.1208	6.9063	8.6918	10.4773	12.2628	14.0483	15.8338	17.6193	19.4048	21.1903	.660	15-16
8 inches	.665	3.3714	4.2743	5.1772	6.9830	8.7888	10.5946	12.4004	14.2062	16.0120	17.8178	19.6236	21.4294	.665	8 inches
8 inches	.670	3.4077	4.3208	5.2339	7.0601	8.8863	10.7125	12.5387	14.3649	16.1911	18.0173	19.8435	21.6697	.670	8 inches
1-16	.675	3.4441	4.3674	5.2908	7.1375	8.9842	10.8309	12.6776	14.5243	16.3710	18.2177	20.0644	21.9111	.675	1-16
2-16	.680	3.4806	4.4142	5.3479	7.2152	9.0825	10.9498	12.8171	14.6844	16.5517	18.4190	20.2863	22.1536	.680	2-16
3-16	.685	3.5172	4.4611	5.4051	7.2930	9.1809	11.0688	12.9567	14.8446	16.7325	18.6204	20.5083	22.3962	.685	3-16
4-16	.690	3.5538	4.5081	5.4624	7.3710	9.2796	11.1882	13.0968	15.0054	16.9140	18.8226	20.7312	22.6396	.690	4-16
5-16	.695	3.5906	4.5553	5.5200	7.4494	9.3788	11.3082	13.2376	15.1670	17.0964	19.0258	20.9552	22.8846	.695	5-16
6-16	.700	3.6275	4.6026	5.5778	7.5281	9.4784	11.4287	13.3790	15.3293	17.2796	19.2299	21.1802	23.1305	.700	6-16
7-16	.705	3.6644	4.6500	5.6356	7.6068	9.5780	11.5492	13.5204	15.4916	17.4628	19.4340	21.4052	23.3764	.705	7-16
8-16	.710	3.7015	4.6976	5.6937	7.6859	9.6781	11.6703	13.6625	15.6547	17.6469	19.6391	21.6318	23.6235	.710	8-16
9-16	.715	3.7387	4.7453	5.7520	7.7653	9.7786	11.7919	13.8052	15.8185	17.8318	19.8451	21.8584	23.8717	.715	9-16
10-16	.720	3.7759	4.7931	5.8103	7.8447	9.8791	11.9135	13.9479	15.9823	18.0167	20.0511	22.0855	24.1199	.720	10-16
11-16	.725	3.81[illegible]3	4.8411	5.8690	7.9247	9.9804	12.0361	14.0918	16.1475	18.2032	20.2589	22.3146	24.3703	.725	11-16
12-16	.730	3.8507	4.8892	5.9277	8.0047	10.0817	12.1587	14.2357	16.3127	18.3897	20.4667	22.5437	24.6207	.730	12-16
13-16	.735	3.8882	4.9373	5.9865	8.0848	10.1831	12.2814	14.3797	16.4780	18.5763	20.6746	22.7729	24.8712	.735	13-16
14-16	.740	3.9259	4.9858	6.0457	8.1655	10.2853	12.4051	14.5249	16.6447	18.7645	20.8843	23.0041	25.1239	.740	14-16
15-16	.745	3.9637	5.0344	6.1051	8.2465	10.3879	12.5293	14.6707	16.8121	18.9535	21.0949	23.2363	25.3777	.745	15-16
9 inches	.750	4.0014	5.0823	6.1643	8.3272	10.4901	12.6530	14.8159	16.9788	19.1417	21.3046	23.4675	25.6304	.750	9 inches

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.											HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	2½ Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
1-16	.755	6.1316	6.2239	8.4085	10.5931	12.7777	14.9623	17.1469	19.3315	21.5161	23.7007	25.8853	.755	1-16
2-16	.760	5.1804	6.2836	8.4899	10.6962	12.9025	15.1088	17.3151	19.5214	21.7277	23.9340	26.1403	.760	2-16
3-16	.765	5.2293	6.3434	8.5715	10.7996	13.0277	15.2558	17.4839	19.7120	21.9401	24.1682	26.3963	.765	3-16
4-16	.770	5.2785	6.4035	8.6535	10.9035	13.1535	15.4035	17.6535	19.9035	22.1535	24.4035	26.6535	.770	4-16
5-16	.775	5.3276	6.4636	8.7355	11.0074	13.2793	15.5512	17.8231	20.0950	22.3669	24.6388	26.9107	.775	5-16
6-16	.780	5.3771	6.5241	8.8181	11.1121	13.4061	15.7001	17.9941	20.2881	22.5821	24.8761	27.1701	.780	6-16
7-16	.785	5.4265	6.5846	8.9007	11.2168	13.5329	15.8490	18.1651	20.4812	22.7973	25.1134	27.4295	.785	7-16
8-16	.790	5.4761	6.6452	8.9834	11.3216	13.6598	15.9980	18.3362	20.6744	23.0126	25.3508	27.6890	.790	8-16
8-16	.795	5.5258	6.7061	9.0666	11.4271	13.7876	16.1481	18.5086	20.8691	23.2296	25.5901	27.9506	.795	8-16
9-16	.800	5.5757	6.7671	9.1499	11.5327	13.9155	16.2983	18.6811	21.0639	23.4467	25.8295	28.2123	.800	9-16
10-16	.805	5.6255	6.8281	9.2332	11.6382	14.0434	16.4485	18.8536	21.2587	23.6638	26.0689	28.4740	.805	10-16
11-16	.810	5.6757	6.8895	9.3171	11.7447	14.1723	16.5999	19.0275	21.4551	23.8827	26.3103	28.7379	.810	11-16
12-16	.815	5.7258	6.9509	9.4010	11.8511	14.3012	16.7513	19.2014	21.6515	24.1016	26.5517	29.0018	.815	12-16
13-16	.820	5.7762	7.0126	9.4853	11.9580	14.4307	16.9034	19.3761	21.8488	24.3215	26.7942	29.2669	.820	13-16
14-16	.825	5.8265	7.0742	9.5695	12.0648	14.5601	17.0554	19.5506	22.0460	24.5413	27.0366	29.5319	.825	14-16
15-16	.830	5.8770	7.1360	9.6540	12.1720	14.6900	17.2080	19.7260	22.2440	24.7620	27.2800	29.7980	.830	15-16
10 inches	.835	5.9277	7.1981	9.7389	12.2797	14.8205	17.3613	19.9021	22.4429	24.9837	27.5245	30.0653	.835	10 inches
1-16	.840	5.9785	7.2604	9.8241	12.3878	14.9515	17.5152	20.0789	22.6426	25.2063	27.7700	30.3337	.840	1-16
2-16	.845	6.0294	7.3227	9.9093	12.4959	15.0825	17.6691	20.2557	22.8423	25.4289	28.0155	30.6021	.845	2-16
3-16	.850	6.0804	7.3852	9.9948	12.6044	15.2140	17.8236	20.4332	23.0428	25.6524	28.2620	30.8716	.850	3-16
4-16	.855	6.1315	7.4479	10.0806	12.7133	15.3460	17.9787	20.6114	23.2441	25.8768	28.5095	31.1422	.855	4-16
5-16	.860	6.1827	7.5106	10.1664	12.8222	15.4780	18.1338	20.7896	23.4454	26.1012	28.7570	31.4128	.860	5-16
6-16	.865	6.2340	7.5735	10.2525	12.9315	15.6105	18.2895	20.9685	23.6475	26.3265	29.0055	31.6845	.865	6-16
7-16	.870	6.2853	7.6364	10.3386	13.0408	15.7430	18.4452	21.1474	23.8496	26.5518	29.2540	31.9562	.870	7-16
8-16	.875	6.3370	7.6998	10.4254	13.1510	15.8766	18.6022	21.3278	24.0534	26.7790	29.5046	32.2302	.875	8-16
9-16	.880	6.3886	7.7631	10.5121	13.2611	16.0101	18.7591	21.5081	24.2571	27.0061	29.7551	32.5041	.880	9-16
10-16	.885	6.4403	7.8265	10.5989	13.3713	16.1437	18.9161	21.6885	24.4609	27.2333	30.0057	32.7781	.885	10-16
11-16	.890	6.4921	7.8901	10.6860	13.4819	16.2778	19.0737	21.8696	24.6655	27.4614	30.2573	33.0532	.890	11-16
12-16	.895	6.5440	7.9538	10.7733	13.5928	16.4123	19.2318	32.0513	24.8708	27.6903	30.5098	33.3293	.895	12-16
13-16	.900	6.5962	8.0178	10.8610	13.7042	16.5474	19.3906	22.2338	25.0770	27.9202	30.7634	33.6066	.900	13-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.										HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
14-16	.905	8.0818	10.9487	13.8156	16.6825	19.5494	22.4163	25.2832	28.1501	31.0170	33.8839	.905	14-16
15-16	.910	8.1460	11.0367	13.9274	16.8181	19.7088	22.5995	25.4902	28.3809	31.2716	34.1622	.910	14-16
11 inches	.915	8.2104	11.1250	14.0396	16.9542	19.8688	22.7834	25.6980	28.6126	31.5272	34.4418	.915	11 inches
11 inches	.920	8.2748	11.2133	14.1518	17.0903	20.0288	22.9673	25.9058	28.8443	31.7828	34.7213	.920	11 inches
1-16	.925	8.3394	11.3019	14.2644	17.2269	20.1894	23.1519	26.1144	29.0769	32.0394	35.0019	.925	1-16
2-16	.930	8.4040	11.3905	14.3770	17.3635	20.3500	23.3365	26.3230	29.3095	32.2960	35.2825	.930	2-16
3-16	.935	8.4691	11.4798	14.4905	17.5012	20.5119	23.5226	26.5333	29.5440	32.5547	35.5654	.935	3-16
4-16	.940	8.5339	11.5687	14.6035	17.6383	20.6731	23.7079	26.7427	29.7775	32.8123	35.8471	.940	4-16
5-16	.945	8.5991	11.6582	14.7173	17.7764	20.8355	23.8946	26.9537	30.0128	33.0719	36.1310	.945	5-16
6-16	.950	8.6644	11.7478	14.8312	17.9146	20.9980	24.0814	27.1648	30.2482	33.3316	36.4150	.950	6-16
7-16	.955	8.7298	11.8376	14.9454	18.0532	21.1610	24.2688	27.3766	30.4844	33.5922	36.7000	.955	7-16
8-16	.960	8.7952	11.9274	15.0596	18.1918	21.3240	24.4562	27.5884	30.7206	33.8528	36.9850	.960	8-16
9-16	.965	8.8608	12.0175	15.1742	18.3309	21.4876	24.6443	27.8010	30.9577	34.1144	37.2711	.965	9-16
10-16	.970	8.9267	12.1080	15.2893	18.4706	21.6519	24.8332	28.0145	31.1958	34.3771	37.5584	.970	10-16
11-16	.975	8.9925	12.1984	15.4043	18.6102	21.8161	25.0220	28.2279	31.4338	34.6397	37.8456	.975	11-16
12-16	.980	9.0586	12.2892	15.5198	18.7504	21.9810	25.2116	28.4422	31.6728	34.9034	38.1340	.980	12-16
13-16	.985	9.1248	12.3802	15.6356	18.8910	22.1464	25.4018	28.6572	31.9126	35.1680	38.4234	.985	13-16
14-16	.990	9.1911	12.4713	15.7515	19.0317	22.3119	25.5921	28.8723	32.1525	35.4327	38.7129	.990	14-16
15-16	.995	9.2575	12.5626	15.8677	19.1728	22.4779	25.7830	29.0881	32.3932	35.6983	39.0034	.995	15-16
12 inches	1.000	9.3240	12.6540	15.9840	19.3140	22.6440	25.9740	29.3040	32.6340	35.9640	39.2940	1.000	12 inches
1-16	1.005	9.3906	12.7456	16.1006	19.4556	22.8106	26.1656	29.5206	32.8756	36.2306	39.5856	1.005	1-16
2-16	1.010	9.4573	12.8376	16.2177	19.5978	22.9779	26.3580	29.7381	33.1182	36.4983	39.8784	1.010	2-16
3-16	1.015	9.5243	12.9295	16.3347	19.7399	23.1451	26.5503	29.9555	33.3607	36.7659	40.1711	1.015	3-16
4-16	1.020	9.5914	13.0218	16.4522	19.8826	23.3130	26.7434	30.1738	33.6042	37.0346	40.4650	1.020	4-16
5-16	1.025	9.6586	13.1143	16.5700	20.0257	23.4814	26.9371	30.3928	33.8485	37.3042	40.7599	1.025	5-16
6-16	1.030	9.7259	13.2069	16.6879	20.1689	23.6499	27.1309	30.6119	34.0929	37.5739	41.0549	1.030	6-16
7-16	1.035	9.7931	13.2994	16.8057	20.3120	23.8183	27.3246	30.8309	34.3372	37.8435	41.3498	1.035	7-16
8-16	1.040	9.8608	13.3926	16.9244	20.4562	23.9880	27.5198	31.0516	34.5834	38.1152	41.6470	1.040	8-16
8-16	1.045	9.9284	13.4857	17.0430	20.6003	24.1576	27.7149	31.2722	34.8295	38.3868	41.9441	1.045	8-16
9-16	1.050	9.9960	13.5788	17.1616	20.7444	24.3272	27.9100	31.4928	35.0756	38.6584	42.2412	1.050	9-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.										HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	3 Feet Long.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
10-16	1.055	10.0641	13.6726	17.2811	20.8896	24.4981	28.1066	31.7151	35.3236	38.9321	42.5406	1.055	10-16
11-16	1.060	10.1331	13.7663	17.4005	21.0347	24.6689	28.3031	31.9373	35.5715	39.2057	42.8399	1.060	11-16
12-16	1.065	10.2001	13.8600	17.5199	21.1798	24.8397	28.4996	32.1595	35.8194	39.4793	43.1392	1.065	12-16
13-16	1.070	10.2634	13.9541	17.6398	21.3255	25.0112	28.6969	32.3826	36.0683	39.7540	43.4397	1.070	13-16
14-16	1.075	10.3368	14.0484	17.7600	21.4716	25.1832	28.8948	32.6064	36.3180	40.0296	43.7412	1.075	14-16
15-16	1.080	10.4052	14.1427	17.8802	21.6177	25.3552	29.0927	32.8302	36.5677	40.3052	44.0427	1.080	15-16
13 inches	1.085	10.4728	14.2373	18.0008	21.7643	25.5278	29.2913	33.0548	36.8183	40.5818	44.3453	1.085	13 inches
1-16	1.090	10.5424	14.3319	18.1214	21.9109	25.7004	29.4899	33.2794	37.0689	40.8584	44.6479	1.090	1-16
2-16	1.095	10.6112	14.4268	18.2424	22.0580	25.8736	29.6892	33.5048	37.3204	41.1360	44.9516	1.095	2-16
3-16	1.100	10.6802	14.5220	18.3638	22.2056	26.0474	29.8892	33.7310	37.5728	41.4146	45.2564	1.100	3-16
4-16	1.105	10.7492	14.6172	18.4852	22.3532	26.2212	30.0892	33.9572	37.8252	41.6932	45.5612	1.105	4-16
5-16	1.110	10.8184	14.7127	18.6070	22.5013	26.3956	30.2899	34.1842	38.0785	41.9728	45.8671	1.110	5-16
6-16	1.115	10.8875	14.8081	18.7257	22.6493	26.5699	30.4905	34.4111	38.3317	42.2523	46.1729	1.115	6-16
7-16	1.120	10.9569	14.9039	18.8509	22.7979	26.7449	30.6919	34.6389	38.5859	42.5329	46.4799	1.120	7-16
8-16	1.125	11.0265	15.0000	18.9735	22.9470	26.9205	30.8940	34.8675	38.8410	42.8145	46.7880	1.125	8-16
9-16	1.130	11.0960	15.0960	19.0960	23.0960	27.0960	31.0960	35.0960	39.0960	43.0960	47.0960	1.130	9-16
10-16	1.135	11.1658	15.1924	19.2190	23.2456	27.2722	31.2988	35.3254	39.3520	43.3786	47.4052	1.135	10-16
11-16	1.140	11.2355	15.2887	19.3419	23.3951	27.4483	31.5015	35.5547	39.6079	43.6611	47.7143	1.140	11-16
12-16	1.145	11.3054	15.3853	19.4652	23.5451	27.6250	31.7049	35.7848	39.8647	43.9446	48.0245	1.145	12-16
13-16	1.150	11.3756	15.4823	19.5890	23.6957	27.8024	31.9091	36.0158	40.1225	44.2292	48.3359	1.150	13-16
14-16	1.155	11.4457	15.5792	19.7127	23.8462	27.9797	32.1132	36.2467	40.3802	44.5137	48.6472	1.155	14-16
15-16	1.160	11.5160	15.6764	19.8368	23.9972	28.1576	32.3180	36.4784	40.6388	44.7992	48.9596	1.160	15-16
14 inches	1.165	11.5862	15.7735	19.9608	24.1481	28.3354	32.5227	36.7100	40.8973	45.0846	49.2719	1.165	14 inches
14 inches	1.170	11.6567	15.8710	20.0853	24.2996	28.5139	32.7282	36.9425	41.1568	45.3711	49.5854	1.170	14 inches
1-16	1.175	11.7272	15.9685	20.2098	24.4511	28.6924	32.9337	37.1750	41.4163	45.6576	49.8989	1.175	1-16
2-16	1.180	11.7979	16.0663	20.3347	24.6031	28.8715	33.1399	37.4083	41.6767	45.9451	50.2135	1.180	2-16
3-16	1.185	11.8687	16.1643	20.4599	24.7555	29.0511	33.3467	37.6423	41.9379	46.2335	50.5291	1.185	3-16
4-16	1.190	11.9396	16.2624	20.5852	24.9080	29.2308	33.5536	37.8764	42.1992	46.5220	50.8418	1.190	4-16
5-16	1.195	12.0106	16.3607	20.7108	25.06[illegible]	29.4110	33.7611	38.1112	42.4613	46.8114	51.1615	1.195	5-16
6-16	1.200	12.0816	16.4590	20.8364	25.2135	29.5912	33.9686	38.3460	42.7234	47.1008	51.4782	1.200	6-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.									HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
7-16	1.205	16.5576	20.9624	25.3672	29.7720	34.1768	38.5816	42.9864	47.3912	51.7960	1.205	7-16
8-16	1.210	16.6562	21.0884	25.5206	29.9528	34.3850	38.8172	43.2494	47.6816	52.1138	1.210	8-16
9-16	1.215	16.7551	21.2148	25.6745	30.1342	34.5939	39.0536	43.5133	47.9730	52.4327	1.215	9-16
10-16	1.220	16.8543	21.3416	25.8289	30.3162	34.8035	39.2908	43.7781	48.2654	52.7527	1.220	10-16
11-16	1.225	16.9535	21.4684	25.9833	30.4982	35.0131	39.5280	44.0429	48.5578	53.0727	1.225	11-16
12-16	1.230	17.0529	21.5955	26.1381	30.6807	35.2233	39.7659	44.3085	48.8511	53.3937	1.230	12-16
13-16	1.235	17.1523	21.7226	26.2929	30.8632	35.4335	40.0038	44.5741	49.1444	53.7147	1.235	13-16
14-16	1.240	17.2521	21.8502	26.4483	31.0464	35.6445	40.2426	44.8407	49.4388	54.0369	1.240	14-16
15-16	1.245	17.3518	21.9777	26.6036	31.2295	35.8554	40.4813	45.1072	49.7331	54.3590	1.245	15-16
15 inches	1.250	17.4518	22.1056	26.7594	31.4132	36.0670	40.7208	45.3746	50.0284	54.6822	1.250	15 inches
1-16	1.255	17.5520	22.2338	26.9156	31.5974	36.2792	40.9610	45.6428	50.3246	55.0064	1.255	1-16
2-16	1.260	17.6523	22.3621	27.0719	31.7817	36.4915	41.2013	45.9111	50.6209	55.3307	1.260	2-16
3-16	1.265	17.7526	22.4904	27.2282	31.9660	36.7038	41.4416	46.1794	50.9172	55.6550	1.265	3-16
4-16	1.270	17.8534	22.6194	27.3854	32.1514	36.9174	41.6834	46.4494	51.2154	55.9814	1.270	4-16
5-16	1.275	17.9539	22.7480	27.5421	32.3362	37.1303	41.9244	46.7185	51.5126	56.3067	1.275	5-16
6-16	1.280	18.0550	22.8774	27.6998	32.5222	37.3446	42.1670	46.9894	51.8118	56.6342	1.280	6-16
7-16	1.285	18.1558	23.0064	27.8570	32.7076	37.5582	42.4088	47.2594	52.1100	56.9606	1.285	7-16
8-16	1.290	18.2572	23.1362	28.0152	32.8942	37.7732	42.6522	47.5312	52.4102	57.2892	1.290	8-16
8-16	1.295	18.3586	23.2660	28.1734	33.0808	37.9882	42.8956	47.8030	52.7104	57.6178	1.295	8-16
9-16	1.300	18.4599	23.3957	28.3315	33.2673	38.2031	43.1389	48.0747	53.0105	57.9463	1.300	9-16
10-16	1.305	18.5616	23.5259	28.4902	33.4545	38.4188	43.3831	48.3474	53.3117	58.2760	1.305	10-16
11-16	1.310	18.6634	23.6563	28.6492	33.6421	38.6350	43.6279	48.6208	53.6137	58.6066	1.310	11-16
12-16	1.315	18.7653	23.7868	28.8083	33.8298	38.8513	43.8728	48.8943	53.9158	58.9373	1.315	12-16
13-16	1.320	18.8675	23.9177	28.9679	34.0181	39.0683	44.1185	49.1687	54.2189	59.2691	1.320	13-16
14-16	1.325	18.9697	24.0486	29.1275	34.2064	39.2853	44.3642	49.4431	54.5220	59.6009	1.325	14-16
15-16	1.330	19.0721	24.1798	29.2875	34.3952	39.5029	44.6106	49.7183	54.8260	59.9337	1.330	15-16
16 inches	1.335	19.1745	24.3110	29.4475	34.5840	39.7215	44.8570	49.9935	55.1300	60.2665	1.335	16 inches
1-16	1.340	19.2772	24.4426	29.6080	34.7734	39.9388	45.1042	50.2696	55.4350	60.6004	1.340	1-16
2-16	1.345	19.3799	24.5742	29.7685	34.9628	40.1571	45.3514	50.5457	55.7400	60.9343	1.345	2-16
3-16	1.350	19.4829	24.7062	29.9295	35.1528	40.3761	45.5994	50.8227	56.0460	61.2693	1.350	3-16

Discharge over Rectangular Weirs—Continued

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS									HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
4-16	1.355	19.5859	24.8382	30.0905	35.3428	40.5951	45.8474	51.0997	56.3520	61.6043	1.355	4-16
5-16	1.360	19.6891	24.9705	30.2519	35.5333	40.8147	46.0961	51.3775	56.6589	61.9403	1.360	5-16
6-16	1.365	19.7926	25.1032	30.4138	35.7244	41.0350	46.3456	51.6562	56.9668	62.2774	1.365	6-16
7-16	1.370	19.8962	25.2359	30.5757	35.9155	41.2553	46.5951	51.9349	57.2747	62.6145	1.370	7-16
8-16	1.375	20.0000	25.3690	30.7381	36.1072	41.4763	46.8454	52.2145	57.5836	62.9527	1.375	8-16
9-16	1.380	20.1036	25.5020	30.9004	36.2988	41.6972	47.0956	52.4940	57.8924	63.2908	1.380	9-16
10-16	1.385	20.2074	25.6351	31.0628	36.4905	41.9182	47.3459	52.7736	58.2013	63.6290	1.385	10-16
11-16	1.390	20.3116	25.7689	31.2261	36.6833	42.1405	47.5977	53.0549	58.5151	63.9693	1.390	11-16
12-16	1.395	20.4156	25.9022	31.3888	36.8754	42.3620	47.8486	53.3352	58.8218	64.3084	1.395	12-16
13-16	1.400	20.5202	26.0364	31.5526	37.0688	42.5850	48.1012	53.6174	59.1336	64.6498	1.400	13-16
14-16	1.405	20.6245	26.1702	31.7159	37.2616	42.8073	48.3530	53.8987	59.4444	64.9901	1.405	14-16
15-16	1.410	20.7293	26.3047	31.8801	37.4555	43.0309	48.6063	54.1817	59.7571	65.3325	1.410	15-16
17 inches	1.415	20.8338	26.4388	32.0438	37.6488	43.2538	48.8588	54.4638	60.0688	65.6738	1.415	17 inches
17 inches	1.420	20.9389	26.5737	32.2085	37.8433	43.4781	49.1129	54.7477	60.3825	66.0173	1.420	17 inches
1-16	1.425	21.0440	26.7086	32.3732	38.0378	43.7024	49.3670	55.0316	60.6962	66.3608	1.425	1-16
2-16	1.430	21.1490	26.8434	32.5378	38.2322	43.9266	49.6210	55.3154	61.0098	66.7042	1.430	2-16
3-16	1.435	21.2543	26.9786	32.7029	38.4272	44.1515	49.8758	55.6001	61.3244	67.0487	1.435	3-16
4-16	1.440	21.3596	27.1138	32.8680	38.6222	44.3764	50.1306	55.8848	61.6390	67.3932	1.440	4-16
5-16	1.445	21.4652	27.2494	33.0336	38.8178	44.6020	50.3862	56.1704	61.9546	67.7388	1.445	5-16
6-16	1.450	21.5710	27.3853	33.1996	39.0139	44.8282	50.6425	56.4568	62.2711	68.0854	1.450	6-16
7-16	1.455	21.6769	27.5213	33.3657	39.2101	45.0545	50.8989	56.7433	62.5877	68.4321	1.455	7-16
8-16	1.460	21.7827	27.6572	33.5317	39.4062	45.2807	51.1552	57.0297	62.9042	68.7787	1.460	8-16
9-16	1.465	21.8888	27.7935	33.6982	39.6029	45.5076	51.4123	57.3170	63.2217	69.1264	1.465	9-16
10-16	1.470	21.9951	27.9301	33.8651	39.8001	45.7351	51.6701	57.6051	63.5401	69.4751	1.470	10-16
11-16	1.475	22.1013	28.0667	34.0320	39.9973	45.9626	51.9279	57.8932	63.8585	69.8238	1.475	11-16
12-16	1.480	22.2081	28.2033	34.1995	40.1952	46.1909	52.1866	58.1823	64.1780	70.1737	1.480	12-16
13-16	1.485	22.3146	28.3407	34.3668	40.3929	46.4190	52.4451	58.4712	64.4973	70.5234	1.485	13-16
14-16	1.490	22.4212	28.4777	34.5342	40.5907	46.6472	52.7037	58.7602	64.8167	70.8732	1.490	14-16
15-16	1.495	22.5280	28.6150	34.7020	40.7890	46.8760	52.9630	59.0500	65.1370	71.2240	1.495	15-16
18 inches	1.500	22.6351	28.7527	34.8703	40.9879	47.1055	53.2231	59.3407	65.4583	71.5759	1.500	18 inches

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.									HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
1-16	1.505	22.7422	28.8904	35.0386	41.1868	47.3350	53.4832	59.6314	65.7796	71.9278	1.505	1-16
2-16	1.510	22.8496	29.0285	35.2074	41.3863	47.5652	53.7441	59.9230	66.1019	72.2808	1.510	2-16
3-16	1.515	22.9569	29.[illegible]365	35.3761	41.5857	47.7953	54.0049	60.2145	66.4241	72.6337	1.516	3-16
4-16	1.520	23.0645	29.[illegible]049	35.5453	41.7857	48.0261	54.2665	60.5069	66.7473	72.9877	1.520	4-16
5-16	1.525	23.1721	2[illegible].4433	35.7145	41.9857	48.2569	54.5281	60.7993	67.0705	73.3417	1.525	5-16
6-16	1.530	23.2796	29.5816	35.8836	42.1856	48.4876	54.7896	61.0916	67.3936	73.6956	1.530	6-16
7-16	1.535	23.3874	29.7203	36.0532	42.3861	48.7190	55.0519	61.3848	67.7177	74.0506	1.535	7-16
8-16	1.540	23.4955	29.8594	36.2233	42.5872	48.9511	55.3150	61.6789	68.0428	74.4067	1.540	8-16
8-16	1.545	23.6036	29.9985	36.3934	42.7883	49.1832	55.5781	61.9730	68.3679	74.7628	1.545	8-16
9-16	1.550	23.7120	30.1380	36.5640	42.9900	49.4160	55.8420	62.2680	68.6940	75.1200	1.550	9-16
10-16	1.555	23.8204	30.2775	36.7346	43.1917	49.6488	56.1059	62.5630	69.0201	75.4772	1.555	10-16
11-16	1.560	23.9289	30.4172	36.9055	43.3968	49.8821	56.3704	62.8587	69.3470	75.8353	1.560	11-16
12-16	1.565	24.0374	30.5569	37.0764	43.5959	50.1154	56.6349	63.1544	69.6739	76.1934	1.565	12-16
13-16	1.570	24.1463	30.6971	37.2479	43.7967	50.3495	56.9003	63.4511	70.0019	76.5527	1.570	13-16
14-16	1.575	24.2551	30.8372	37.4193	44.0014	50.5835	57.1656	63.7477	70.3298	76.9119	1.575	14-19
15-16	1.580	24.3641	30.9776	37.5911	44.2046	50.8181	57.4316	64.0451	70.6586	77.2721	1.580	15-16
19 inches	1.585	24.4732	31.1181	37.7630	44.4079	51.0528	57.6977	64.3426	70.9875	77.6324	1.585	19 inches
1-16	1.590	24.5825	31.2589	37.9353	44.6117	51.2881	57.9645	64.6409	71.3173	77.9937	1.590	1-16
2-16	1.595	24.6918	31.3997	38.1076	44.8155	51.5234	58.2313	64.9392	71.6471	78.3550	1.595	2-16
3-16	1.600	24.8010	31.5404	38.2798	45.0192	51.7586	58.4980	65.2374	71.9768	78.7162	1.600	3-16
4-16	1.605	24.9105	31.6815	38.4525	45.2235	51.9945	58.7655	65.5365	72.3075	79.0785	1.605	4-16
5-16	1.610	25.0204	31.8231	38.6258	45.4285	52.2312	59.0339	65.8366	72.6393	79.4420	1.610	5-16
6-16	1.615	25.1301	31.9645	38.7989	45.6333	52.4677	59.3021	66.1365	72.9709	79.8053	1.615	6-16
7-16	1.620	25.2402	32.1064	38.9726	45.8388	52.7050	59.5712	66.4374	73.3036	80.1698	1.620	7-16
8-16	1.625	25.3502	32.2482	39.1462	46.0442	52.9422	59.8402	66.7382	73.6362	80.5342	1.625	8-16
9-16	1.630	25.4604	32.3903	39.3202	46.2501	53.1800	60.1099	67.0398	73.9697	80.8996	1.630	9-16
10-16	1.635	25.5707	32.5325	39.4943	46.4561	53.4179	60.3797	67.3415	74.3033	81.2651	1.635	10-16
11-16	1.640	25.6809	32.6746	39.6683	46.6620	53.6557	60.6494	67.6431	74.6368	81.6305	1.640	11-16
12-16	1.645	25.7917	32.8175	39.8433	46.8691	53.8949	60.9207	67.9465	74.9723	81.9981	1.646	12-16
13-16	1.650	25.9021	32.9599	40.0177	47.0755	54.1333	61.1911	68.2489	75.3067	82.3645	1.650	13-16

Discharge over Rectangular Weirs—Continued

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS									HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
4-16	1.355	19.5859	24.8382	30.0905	35.3428	40.5951	45.8474	51.0997	56.3520	61.6043	1.355	4-16
5-16	1.360	19.6891	24.9706	30.2519	35.5333	40.8147	46.0961	51.3775	56.6589	61.9403	1.360	5-16
6-16	1.365	19.7926	25.1032	30.4138	35.7244	41.0350	46.3456	51.6562	56.9668	62.2774	1.365	6-16
7-16	1.370	19.8962	25.2359	30.5757	35.9155	41.2553	46.5951	51.9349	57.2747	62.6145	1.370	7-16
8-16	1.375	20.0000	25.3690	30.7381	36.1072	41.4763	46.8454	52.2145	57.5836	62.9527	1.375	8-16
9-16	1.380	20.1036	25.5020	30.9004	36.2988	41.6972	47.0956	52.4940	57.8924	63.2908	1.380	9-16
10-16	1.385	20.2074	25.6351	31.0628	36.4906	41.9182	47.3459	52.7736	58.2013	63.6290	1.385	10-16
11-16	1.390	20.3116	25.7689	31.2261	36.6833	42.1405	47.5977	53.0549	58.5151	63.9693	1.390	11-16
12-16	1.395	20.4156	25.9022	31.3888	36.8754	42.3620	47.8486	53.3352	58.8218	64.3084	1.395	12-16
13-16	1.400	20.5202	26.0364	31.5526	37.0688	42.5850	48.1012	53.6174	59.1336	64.6498	1.400	13-16
14-16	1.405	20.6245	26.1702	31.7159	37.2616	42.8073	48.3530	53.8987	59.4444	64.9901	1.405	14-16
15-16	1.410	20.7293	26.3047	31.8801	37.4555	43.0309	48.6063	54.1817	59.7571	65.3325	1.410	15-16
17 inches	1.415	20.8338	26.4388	32.0438	37.6488	43.2538	48.8588	54.4638	60.0688	65.6738	1.415	17 inches
17 inches	1.420	20.9389	26.5737	32.2085	37.8433	43.4781	49.1129	54.7477	60.3825	66.0173	1.420	17 inches
1-16	1.425	21.0440	26.7086	32.3732	38.0378	43.7024	49.3670	55.0316	60.6962	66.3608	1.425	1-16
2-16	1.430	21.1490	26.8434	32.5378	38.2322	43.9266	49.6210	55.3154	61.0098	66.7042	1.430	2-16
3-16	1.435	21.2543	26.9786	32.7029	38.4272	44.1515	49.8758	55.6001	61.3244	67.0487	1.435	3-16
4-16	1.440	21.3596	27.1138	32.8680	38.6222	44.3764	50.1306	55.8848	61.6390	67.3932	1.440	4-16
5-16	1.445	21.4652	27.2494	33.0336	38.8178	44.6020	50.3862	56.1704	61.9546	67.7388	1.445	5-16
6-16	1.450	21.5710	27.3853	33.1996	39.0139	44.8282	50.6425	56.4568	62.2711	68.0854	1.450	6-16
7-16	1.455	21.6769	27.5213	33.3657	39.2101	45.0545	50.8989	56.7433	62.5877	68.4321	1.455	7-16
8-16	1.460	21.7827	27.6572	33.5317	39.4062	45.2807	51.1552	57.0297	62.9042	68.7787	1.460	8-16
9-16	1.465	21.8888	27.7935	33.6982	39.6029	45.5076	51.4123	57.3170	63.2217	69.1264	1.465	9-16
10-16	1.470	21.9951	27.9301	33.8651	39.8001	45.7351	51.6701	57.6051	63.5401	69.4751	1.470	10-16
11-16	1.475	22.1013	28.0667	34.0320	39.9973	45.9626	51.9279	57.8932	63.8585	69.8238	1.475	11-16
12-16	1.480	22.2081	28.2038	34.1995	40.1952	46.1909	52.1866	58.1823	64.1780	70.1737	1.480	12-16
13-16	1.485	22.3146	28.3407	34.3668	40.3929	46.4190	52.4451	58.4712	64.4973	70.5234	1.485	13-16
14-16	1.490	22.4212	28.4777	34.5342	40.5907	46.6472	52.7037	58.7602	64.8167	70.8732	1.490	14-16
15-16	1.495	22.5280	28.6150	34.7020	40.7890	46.8760	52.9630	59.0500	65.1370	71.2240	1.495	15-16
18 inches	1.500	22.6351	28.7527	34.8703	40.9879	47.1055	53.2231	59.3407	65.4583	71.5759	1.500	18 inches

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20. In Inches. (Approximately.)	In Feet.	DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS. 4 Feet Long.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	HEAD, H, On Crest. Measured to still water. See page 20. In Feet.	In Inches. (Approximately.)
1-16	1.505	22.7422	28.8904	35.0386	41.1868	47.3350	53.4832	59.6314	65.7796	71.9278	1.505	1-16
2-16	1.510	22.8496	29.0285	35.2074	41.3863	47.5652	53.7441	59.9230	66.1019	72.2808	1.510	2-16
3-16	1.515	22.9569	29.1665	35.3761	41.5857	47.7953	54.0049	60.2145	66.4241	72.6337	1.515	3-16
4-16	1.520	23.0645	29.3049	35.5453	41.7857	48.0261	54.2665	60.5069	66.7473	72.9877	1.520	4-16
5-16	1.525	23.1721	29.4433	35.7145	41.9857	48.2569	54.5281	60.7993	67.0705	73.3417	1.525	5-16
6-16	1.530	23.2796	29.5816	35.8836	42.1856	48.4876	54.7896	61.0916	67.3936	73.6956	1.530	6-16
7-16	1.535	23.3874	29.7203	36.0532	42.3861	48.7190	55.0519	61.3848	67.7177	74.0506	1.535	7-16
8-16	1.540	23.4955	29.8594	36.2233	42.5872	48.9511	55.3150	61.6789	68.0428	74.4067	1.540	8-16
8-16	1.545	23.6036	29.9985	36.3934	42.7883	49.1832	55.5781	61.9730	68.3679	74.7628	1.545	8-16
9-16	1.550	23.7120	30.1380	36.5640	42.9900	49.4160	55.8420	62.2680	68.6940	75.1200	1.550	9-16
10-16	1.555	23.8204	30.2775	36.7346	43.1917	49.6488	56.1059	62.5630	69.0201	75.4772	1.555	10-16
11-16	1.560	23.9289	30.4172	36.9055	43.3968	49.8821	56.3704	62.8587	69.3470	75.8353	1.560	11-16
12-16	1.565	24.0374	30.5569	37.0764	43.5959	50.1154	56.6349	63.1544	69.6739	76.1934	1.565	12-16
13-16	1.570	24.1463	30.6971	37.2479	43.7987	50.3495	56.9003	63.4511	70.0019	76.5527	1.570	13-16
14-16	1.575	24.2551	30.8372	37.4193	44.0014	50.5835	57.1656	63.7477	70.3298	76.9119	1.575	14-19
15-16	1.580	24.3641	30.9776	37.5911	44.2046	50.8181	57.4316	64.0451	70.6586	77.2721	1.580	15-16
19 inches	1.585	24.4732	31.1181	37.7630	44.4079	51.0528	57.6977	64.3426	70.9875	77.6324	1.585	19 inches
1-16	1.590	24.5825	31.2589	37.9353	44.6117	51.2881	57.9645	64.6409	71.3173	77.9937	1.590	1-16
2-16	1.595	24.6918	31.3997	38.1076	44.8155	51.5234	58.2313	64.9392	71.6471	78.3550	1.595	2-16
3-16	1.600	24.8010	31.5404	38.2798	45.0192	51.7586	58.4980	65.2374	71.9768	78.7162	1.600	3-16
4-16	1.605	24.9105	31.6815	38.4525	45.2235	51.9945	58.7655	65.5365	72.3075	79.0785	1.605	4-16
5-16	1.610	25.0204	31.8231	38.6258	45.4285	52.2312	59.0339	65.8366	72.6393	79.4420	1.610	5-16
6-16	1.615	25.1301	31.9645	38.7989	45.6333	52.4677	59.3021	66.1365	72.9709	79.8053	1.615	6-16
7-16	1.620	25.2402	32.1064	38.9726	45.8388	52.7050	59.5712	66.4374	73.3036	80.1698	1.620	7-16
8-16	1.625	25.3502	32.2482	39.1462	46.0442	52.9422	59.8402	66.7382	73.6362	80.5342	1.625	8-16
9-16	1.630	25.4604	32.3903	39.3202	46.2501	53.1800	60.1099	67.0398	73.9697	80.8996	1.630	9-16
10-16	1.635	25.5707	32.5325	39.4943	46.4561	53.4179	60.3797	67.3415	74.3033	81.2651	1.635	10-16
11-16	1.640	25.6809	32.6746	39.6683	46.6620	53.6557	60.6494	67.6431	74.6368	81.6305	1.640	11-16
12-16	1.645	25.7917	32.8175	39.8433	46.8691	53.8949	60.9207	67.9465	74.9723	81.9981	1.645	12-16
13-16	1.650	25.9021	32.9599	40.0177	47.0755	54.1333	61.1911	68.2489	75.3067	82.3645	1.650	13-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest, Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.								HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
14-16	1.655	33.1028	40.1927	47.2826	54.3725	61.4624	68.5523	75.6422	82.7321	1.655	14-16
15-16	1.660	33.2460	40.3681	47.4902	54.6123	61.7344	68.8565	75.9786	83.1007	1.660	15-16
20 inches	1.665	33.3891	40.5434	47.6977	54.8520	62.0063	69.1606	76.3149	83.4692	1.665	20 inches
20 inches	1.670	33.5322	40.7187	47.9052	55.0917	62.2782	69.4647	76.6512	83.8377	1.670	20 inches
1-16	1.675	33.6757	40.8945	48.1133	55.3321	62.5509	69.7697	76.9885	84.2073	1.675	1-16
2-16	1.680	33.8196	41.0708	48.3220	55.5732	62.8244	70.0756	77.3268	84.5780	1.680	2-16
3-16	1.685	33.9634	41.2470	48.5306	55.8142	63.0978	70.3814	77.6650	84.9486	1.685	3-16
4-16	1.690	34.1072	41.4232	48.7392	56.0552	63.3712	70.6872	78.0032	85.3192	1.690	4-16
5-16	1.695	34.2514	41.5999	48.9484	56.2969	63.6454	70.9939	78.3424	85.6909	1.695	5-16
6-16	1.700	34.3955	41.7765	49.1575	56.5385	63.9195	71.3005	78.6815	86.0625	1.700	6-16
7-16	1.705	34.5400	41.9536	49.3672	56.7808	64.1944	71.6080	79.0216	86.4352	1.905	7-16
8-16	1.710	34.6849	42.1311	49.5774	57.0237	64.4700	71.9163	79.3626	86.8089	1.710	8-16
9-16	1.715	34.8293	42.3082	49.7871	57.2660	64.7449	72.2238	79.7027	87.1816	1.715	9-16
10-16	1.720	34.9745	42.4862	49.9979	57.5096	65.0213	72.5330	80.0447	87.5564	1.720	10-16
11-16	1.725	35.1192	42.6636	50.2080	57.7524	65.2968	72.8412	80.3856	87.9300	1.725	11-16
12-16	1.730	35.2648	42.8421	50.4194	57.9967	65.5740	73.1513	80.7286	88.3059	1.730	12-16
13-16	1.735	35.4098	43.0199	50.6300	58.2401	65.8502	73.4603	81.0704	88.6805	1.735	13-16
14-16	1.740	35.5557	43.1988	50.8419	58.4850	66.1281	73.7712	81.4143	89.0574	1.740	14-16
15-16	1.745	35.7011	43.3771	51.0531	58.7291	66.4051	74.0811	81.7571	89.4331	1.745	15-16
21 inches	1.750	35.8473	43.5564	51.2655	58.9746	66.6837	74.3928	82.1019	89.8110	1.750	21 inches
1-16	1.755	35.9930	43.7351	51.4772	59.2193	66.9614	74.7035	82.4456	90.1877	1.755	1-16
2-16	1.760	36.1391	43.9143	51.6895	59.4647	67.2399	75.0151	82.7903	90.5655	1.760	2-16
3-16	1.765	36.2856	44.0940	51.9024	59.7108	67.5192	75.3276	83.1360	90.9444	1.765	3-16
4-16	1.770	36.4321	44.2737	52.1153	59.9569	67.7985	75.6401	83.4817	91.3233	1.770	4-16
5-16	1.775	36.5785	44.4533	52.3281	60.2029	68.0777	75.9525	83.8273	91.7021	1.775	5-16
6-16	1.780	36.7252	44.6333	52.5414	60.4495	68.3576	76.2657	84.1738	92.0819	1.780	6-16
7-16	1.785	36.8724	44.8139	52.7554	60.6969	68.6384	76.5799	84.5214	92.4629	1.785	7-16
8-16	1.790	37.0195	44.9944	52.9693	60.9442	68.9191	76.8940	84.8689	92.8438	1.790	8-16
8-16	1.795	37.1665	45.1748	53.1831	61.1914	69.1997	77.2080	85.2163	93.2246	1.795	8-16
9-16	1.800	37.3140	45.3558	53.3976	61.4394	69.4812	77.5230	85.5618	93.6066	1.800	9-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.								HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
10-16	1.805	37.4613	45.5366	53.6119	61.6872	69.7625	77.8378	85.9131	93.9884	1.805	10-16
11-16	1.810	37.6091	45.7180	53.8269	61.9358	70.0447	78.1536	86.2625	94.3714	1.810	11-16
12-16	1.815	37.7568	45.8993	54.0418	62.1843	70.3268	78.4693	86.6118	94.7543	1.815	12-16
13-16	1.820	37.9048	46.0810	54.2572	62.4334	70.6096	78.7858	86.9620	95.1382	1.820	13-16
14-16	1.825	38.0529	46.2628	54.4727	62.6826	70.8925	79.1024	87.3123	95.5222	1.825	14-16
15-16	1.830	38.2013	46.4450	54.6887	62.9324	71.1761	79.4198	87.6635	95.9072	1.830	15-16
22 inches	1.835	38.3497	46.6272	54.9047	63.1822	71.4597	79.7372	88.0147	96.2922	1.835	22 inches
1-16	1.840	38.4980	46.8093	55.1206	63.4319	71.7432	80.0545	88.3658	96.6771	1.840	1-16
2-16	1.845	38.6466	46.9918	55.3370	63.6822	72.0274	80.3726	88.7178	97.0630	1.845	2-16
3-16	1.850	38.7957	47.1749	55.5541	63.9333	72.3125	80.6917	89.0709	97.4501	1.850	3-16
4-16	1.855	38.9447	47.3579	55.7711	64.1843	72.5975	81.0107	89.4239	97.8371	1.855	4-16
5-16	1.860	39.0937	47.5409	55.9881	64.4353	72.8825	81.3297	89.7769	98.2241	1.860	5-16
6-16	1.865	39.2430	47.7243	56.2056	64.6869	73.1682	81.6495	90.1308	98.6121	1.865	6-16
7-16	1.870	39.3923	47.9077	56.4231	64.9385	73.4539	81.9693	90.4847	99.0001	1.870	7-16
8-16	1.875	39.5419	48.0915	56.6411	65.1907	73.7403	82.2899	90.8395	99.3891	1.875	8-16
9-16	1.880	39.6915	48.2753	56.8591	65.4429	74.0267	82.6105	91.1943	99.7781	1.880	9-16
10-16	1.885	39.8415	48.4596	57.0777	65.6958	74.3139	82.9320	91.5501	100.1682	1.885	10-16
11-16	1.890	39.9914	48.6438	57.2962	65.9486	74.6010	83.2534	91.9058	100.5582	1.890	11-16
12-16	1.895	40.1417	48.8285	57.5153	66.2021	74.8889	83.5757	92.2625	100.9493	1.895	12-16
13-16	1.900	40.2919	49.0131	57.7343	66.4555	75.1767	83.8979	92.6191	101.3403	1.900	13-16
14-16	1.905	40.4421	49.1977	57.9533	66.7089	75.4645	84.2201	92.9757	101.7313	1.905	14-16
15-16	1.910	40.5927	49.3828	58.1729	66.9630	75.7531	84.5432	93.3333	102.1234	1.910	15-16
23 inches	1.915	40.7432	49.5678	58.3924	67.2170	76.0416	84.8662	93.6908	102.5154	1.915	23 inches
23 inches	1.920	40.8941	49.7533	58.6125	67.4717	76.3309	85.1901	94.0493	102.9085	1.920	23 inches
1-16	1.925	41.0453	49.9392	58.8331	67.7270	76.6209	85.5148	94.4087	103.3026	1.925	1-16
2-16	1.930	41.1961	50.1246	59.0531	67.9816	76.9101	85.8386	94.7671	103.6956	1.930	2-16
3-16	1.935	41.3473	50.3105	59.2737	68.2369	77.2001	86.1633	95.1265	104.0897	1.935	3-16
4-16	1.940	41.4988	50.4968	59.4948	68.4928	77.4908	86.4888	95.4868	104.4848	1.940	4-16
5-16	1.945	41.6503	50.6831	59.7159	68.7487	77.7815	86.8143	95.8471	104.8799	1.945	5-16
6-16	1.950	41.8021	50.8698	59.9375	69.0052	78.0729	87.1406	96.2083	105.2760	1.950	6-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest, Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.								HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches (Approximately.)	In Feet.	5 Feet Long.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
7-16	1.955	41.9539	51.0565	60.1591	69.2617	78.3643	87.4669	96.5695	105.6721	1.955	7-16
8-16	1.960	42.1056	51.2431	60.3806	69.5181	78.6556	87.7931	96.9306	106.0681	1.960	8-16
9-16	1.965	42.2577	51.4302	60.6027	69.7752	78.9477	88.1202	97.2927	106.4652	1.965	9-16
10-16	1.970	42.4098	51.6173	60.8248	70.0323	79.2398	88.4473	97.6548	106.8623	1.970	10-16
11-16	1.975	42.5622	51.8048	61.0474	70.2900	79.5326	88.7752	98.0178	107.2604	1.975	11-16
12-16	1.980	42.7146	51.9923	61.2700	70.5477	79.8254	89.1031	98.3808	107.6585	1.980	12-16
13-16	1.985	42.8673	52.1802	61.4931	70.8060	80.1189	89.4318	98.7447	108.0576	1.985	13-16
14-16	1.990	43.0200	52.3681	61.7162	71.0643	80.4124	89.7605	99.1086	108.4567	1.990	14-16
15-16	1.995	43.1730	52.5564	61.9398	71.3232	80.7066	90.0900	99.4734	108.8568	1.995	15-16
24 inches	2.000	43.3260	52.7447	62.1634	71.5821	81.0008	90.4195	99.8382	109.2569	2.000	24 inches
1-16	2.005	43.4789	52.9329	62.3869	71.8409	81.2949	90.7489	100.2029	109.6569	2.005	1-16
2-16	2.010	43.6323	53.1217	62.6111	72.1005	81.5899	91.0793	100.5687	110.0581	2.010	2-16
3-16	2.015	43.7855	53.3103	62.8351	72.3599	81.8847	91.4095	100.9343	110.4591	2.015	3-16
4-16	2.020	43.9391	53.4993	63.0597	72.6200	82.1803	91.7406	101.3009	110.8612	2.020	4-16
5-16	2.025	44.0927	53.6885	63.2843	72.8801	82.4759	92.0717	101.6675	111.2633	2.025	5-16
6-16	2.030	44.2466	53.8780	63.5094	73.1408	82.7722	92.4036	102.0350	111.6664	2.030	6-16
7-16	2.035	44.4005	54.0675	63.7345	73.4015	83.0685	92.7355	102.4025	112.0695	2.035	7-16
8-16	2.040	44.5544	54.2570	63.9596	73.6622	83.3648	93.0674	102.7700	112.4726	2.040	8-16
8-16	2.045	44.7085	54.4468	64.1851	73.9234	83.6617	93.4000	103.1383	112.8766	2.045	8-16
9-16	2.050	44.8631	54.6372	64.4113	74.1854	83.9595	93.7336	103.5077	113.2818	2.050	9-16
10-16	2.055	45.0172	54.8270	64.6368	74.4446	84.2564	94.0662	103.8760	113.6858	2.055	10-16
11-16	2.060	45.1720	55.0177	64.8634	74.7091	84.5548	94.4005	104.2462	114.0919	2.060	11-16
12-16	2.065	45.3264	55.2079	65.0894	74.9709	84.8524	94.7339	104.6154	114.4969	2.065	12-16
13-16	2.070	45.4812	55.3986	65.3160	75.2334	85.1508	95.0682	104.9856	114.9030	2.070	13-16
14-16	2.075	45.6363	55.5897	65.5431	75.4965	85.4499	95.4033	105.3567	115.3101	2.075	14-16
15-16	2.080	45.7914	55.7808	65.7702	75.7596	85.7490	95.7384	105.7278	115.7112	2.080	15-16
25 inches	2.085	45.9464	55.9718	65.9972	76.0226	86.0480	96.0734	106.0988	116.1242	2.085	25 inches
1-16	2.090	46.1018	56.1633	66.2248	76.2863	86.3478	96.4093	106.4708	116.5323	2.090	1-16
2-16	2.095	46.2571	56.3547	66.4523	76.5499	86.6475	96.7451	106.8427	116.9403	2.095	2-16
3-16	2.100	46.4128	56.5466	66.6804	76.8142	86.9480	97.0818	107.2156	117.3494	2.100	3-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.							HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
4-16	2.105	56.7384	66.9084	77.0784	87.2484	97.4184	107.5884	117.7584	2.105	4-16
5-16	2.110	56.9307	67.1370	77.3433	87.5496	97.7559	107.9622	118.1685	2.110	5-16
6-16	2.115	57.1229	67.3655	77.6081	87.8507	98.0933	108.3359	118.5785	2.115	6-16
7-16	2.120	57.3151	67.5940	77.8729	88.1518	98.4307	108.7096	118.9885	2.120	7-16
8-16	2.125	57.5073	67.8231	78.1384	88.4537	98.7690	109.0843	119.3996	2.125	8-16
9-16	2.130	57.7009	68.0527	78.4045	88.7563	99.1031	109.4599	119.8117	2.130	9-16
10-16	2.135	57.8935	68.2817	78.6699	89.0581	99.4463	109.8345	120.2227	2.135	10-16
11-16	2.140	58.0865	68.5112	78.9359	89.3606	99.7853	110.2100	120.6347	2.140	11-16
12-14	2.145	58.2799	68.7412	79.2025	89.6638	100.1251	110.5864	121.0477	2.145	12-16
13-16	2.150	58.4733	68.9712	79.4691	89.9670	100.4649	110.9628	121.4607	2.150	13-16
14-16	2.155	58.6666	69.2011	79.7356	90.2701	100.8046	111.3391	121.8736	2.155	14-16
15-16	2.160	58.8605	69.4317	80.0029	90.5741	101.1453	111.7165	122.2877	2.160	15-16
26 inches	2.165	59.0542	69.6621	80.2700	90.8779	101.4858	112.0937	122.7016	2.165	26 inches
26 inches	2.170	59.2484	69.8931	80.5378	91.1825	101.8272	112.4719	123.1166	2.170	26 inches
1-16	2.175	59.4426	70.1241	80.8056	91.4871	102.1686	112.8501	123.5316	2.175	1-16
2-16	2.180	59.6372	70.3556	81.0740	91.7924	102.5108	113.2292	123.9476	2.180	2-16
3-16	2.185	59.8312	70.5864	81.3416	92.0968	102.8520	113.6072	124.3624	2.185	3-16
4-16	2.190	60.0262	70.8184	81.6106	92.4028	103.1950	113.9872	124.7794	2.190	4-16
5-16	2.195	60.2212	71.0504	81.8796	92.7088	103.5380	114.3672	125.1964	2.195	5-15
6-16	2.200	60.4161	71.2823	82.1485	93.0147	103.8809	114.7471	125.6133	2.200	6-16
7-16	2.205	60.6114	71.5147	82.4180	93.3213	104.2246	115.1279	126.0312	2.205	7-16
8-16	2.210	60.8067	71.7471	82.6875	93.6279	104.5683	115.5087	126.4491	2.210	8-16
9-16	2.215	61.0020	71.9795	82.9570	93.9345	104.9120	115.8895	126.8670	2.215	9-16
10-16	2.220	61.1977	72.2124	83.2271	94.2418	105.2565	116.2712	127.2859	2.220	10-16
11-16	2.225	61.3933	72.4452	83.4971	94.5490	105.6009	116.6528	127.7047	2.225	11-16
12-16	2.230	61.5894	72.6786	83.7678	94.8570	105.9462	117.0354	128.1246	2.230	12-16
13-16	2.235	61.7855	72.9120	84.0385	95.1650	106.2915	117.4180	128.5445	2.235	13-16
14-16	2.240	61.9820	73.1459	84.3098	95.4737	106.6376	117.8015	128.9654	2.240	14-16
15-16	2.245	62.1784	73.3797	84.5810	95.7823	106.9836	118.1849	129.3862	2.245	15-16
27 inches	2.250	62.3748	73.6135	84.8522	96.0909	107.3296	118.5683	129.8070	2.250	27 inches

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest, Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.							HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	6 Feet Long.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
1-16	2.255	62.5716	73.8478	85.1240	96.4002	107.6764	118.9526	130.2288	2.255	1-16
2-16	2.260	62.7684	74.0821	85.3958	96.7095	108.0232	119.3369	130.6506	2.260	2-16
3-16	2.265	62.9657	74.3170	85.6683	97.0196	108.3709	119.7222	131.0735	2.265	3-16
4-16	2.270	63.1629	74.5518	85.9407	97.3296	108.7185	120.1074	131.4963	2.270	4-16
5-16	2.275	63.3600	74.7865	86.2130	97.6395	109.0660	120.4925	131.9190	2.275	5-16
6-16	2.280	63.5581	75.0224	86.4867	97.9510	109.4153	120.8796	132.3439	2.280	6-16
7-16	2.285	63.7556	75.2576	86.7596	98.2616	109.7636	121.2656	132.7676	2.285	7-16
8-16	2.290	63.9535	75.4933	87.0331	98.5729	110.1127	121.6525	133.1923	2.290	8-16
8-16	2.295	64.1515	75.7291	87.3067	98.8843	110.4619	122.0395	133.6171	2.295	8-16
9-16	2.300	64.3494	75.9648	87.5802	99.1956	110.8110	122.4264	134.0418	2.300	9-16
10-16	2.305	64.5476	76.2009	87.8542	99.5075	111.1608	122.8141	134.4674	2.305	10-16
11-16	2.310	64.7464	76.4377	88.1290	99.8203	111.5116	123.2029	134.8942	2.310	11-16
12-16	2.315	64.9446	76.6738	88.4030	100.1322	111.8614	123.5906	135.3198	2.315	12-16
13-16	2.320	65.1438	76.9111	88.6784	100.4457	112.2130	123.9803	135.7476	2.320	13-16
14-16	2.325	65.3424	77.1477	88.9530	100.7583	112.5636	124.3689	136.1742	2.325	14-16
15-16	2.330	65.5414	77.3848	89.2282	101.0716	112.9150	124.7584	136.6018	2.330	15-16
28 inches	2.335	65.7409	77.6225	89.5041	101.3857	113.2673	125.1489	137.0305	2.335	28 inches
1-16	2.340	65.9403	77.8601	89.7799	101.6997	113.6195	125.5393	137.4591	2.340	1-16
2-16	2.345	66.1397	78.0977	90.0557	102.0137	113.9717	125.9297	137.8877	2.345	2-16
3-16	2.350	66.3395	78.3358	90.3321	102.3284	114.3247	126.3210	138.3173	2.350	3-16
4-16	2.355	66.5393	78.5739	90.6085	102.6431	114.6777	126.7123	138.7469	2.355	4-16
5-16	2.360	66.7390	78.8119	90.8848	102.9577	115.0306	127.1035	139.1764	2.360	5-16
6-16	2.365	66.9392	79.0505	91.1618	103.2731	115.3844	127.4957	139.6070	2.365	6-16
7-16	2.370	67.1393	79.2890	91.4387	103.5884	115.7381	127.8878	140.0375	2.370	7-16
8-16	2.375	67.3398	79.5280	91.7162	103.9044	116.0926	128.2808	140.4690	2.375	8-16
9-16	2.380	67.5403	79.7670	91.9937	104.2204	116.4471	128.6738	140.9005	2.380	9-16
10-16	2.385	67.7412	80.0065	92.2718	104.5371	116.8024	129.0677	141.3330	2.385	10-16
11-16	2.390	67.9421	80.2460	92.5499	104.8538	117.1577	129.4616	141.7655	2.390	11-16
12-16	2.395	68.1429	80.4854	92.8279	105.1704	117.5129	129.8554	142.1979	2.395	12-16
13-16	2.400	68.3437	80.7248	93.1059	105.4870	117.8681	130.2492	142.6303	2.400	13-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.						HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
14-16	2.405	80.9647	93.3845	105.8043	118.2241	130.6439	143.0637	2.405	14-16
15-16	2.410	81.2062	93.6638	106.1224	118.5810	131.0396	143.4982	2.410	15-16
29 inches	2.415	81.4456	93.9430	106.4404	118.9378	131.4352	143.9326	2.415	29 inches
29 inches	2.420	81.6859	94.2221	106.7583	119.2945	131.8307	144.3669	2.420	29 inches
1-16	2.425	81.9268	95.5019	107.0770	119.6521	132.2272	144.8023	2.425	1-16
2-16	2.430	82.1676	94.7816	107.3956	120.0096	132.6236	145.2376	2.430	2-16
3-16	2.435	82.4084	95.0613	107.7142	120.3671	133.0200	145.6729	2.435	3-16
4-16	2.440	82.6497	95.3416	108.0335	120.7254	133.4173	146.1092	2.440	4-16
5-16	2.445	82.8915	95.6225	108.3535	121.0845	133.8155	146.5465	2.445	5-16
6-16	2.450	83.1333	95.9034	108.6735	121.4436	134.2137	146.9838	2.450	6-16
7-16	2.455	83.3750	96.1842	108.9934	121.8026	134.6118	147.4210	2.455	7-16
8-16	2.460	83.6167	96.4650	109.3133	122.1616	135.0099	147.8582	2.460	8-16
9-16	2.465	83.8589	96.7464	109.6339	122.5214	135.4089	148.2964	2.465	9-16
10-16	2.470	84.1011	97.0278	109.9545	122.8812	135.8079	148.7346	2.470	10-16
11-16	2.475	84.3433	97.3098	110.2758	123.2418	136.2078	149.1738	2.475	11-16
12-16	2.480	84.5865	97.5918	110.5971	123.6024	136.6077	149.6130	2.480	12-16
13-16	2.485	84.8297	97.8744	110.9191	123.9638	137.0085	150.0532	2.485	13-16
14-16	2.490	85.0728	98.1569	111.2410	124.3251	137.4092	150.4933	2.490	14-16
15-16	2.495	85.3159	98.4394	111.5629	124.6864	137.8099	150.9334	2.495	15-16
30 inches	2.500	85.5595	98.7225	111.8855	125.0485	138.2115	151.3745	2.500	30 inches
1-16	2.505	85.8031	99.0056	112.2081	125.4106	138.6131	151.8156	2.505	1-16
2-16	2.510	86.0465	99.2885	112.5305	125.7725	139.0145	152.2565	2.510	2-16
3-16	2.515	86.2906	99.5722	112.8538	126.1354	139.4170	152.6986	2.515	3-16
4-16	2.520	86.5347	99.8560	113.1773	126.4986	139.8199	153.1412	2.520	4-16
5-16	2.525	86.7790	100.1399	113.5008	126.8617	140.2226	153.5835	2.525	5-16
6-16	2.530	87.0235	100.4241	113.8247	127.2253	140.6259	154.0265	2.530	6-16
7-16	2.535	87.2685	100.7089	114.1493	127.5897	141.0301	154.4705	2.535	7-16
8-16	2.540	87.5134	100.9936	114.4738	127.9540	141.4342	154.9144	2.540	8-16
8-16	2.545	87.7583	101.2783	114.7983	128.3183	141.8383	155.3583	2.545	8-16
9-16	2.550	88.0031	101.5629	115.1227	128.6825	142.2423	155.8021	2.550	9-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest. Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.						HEAD, H, On Crest. Measured to still water. See page 20.	
In Inches. (Approximately.)	In Feet.	7 Feet Long.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.	In Feet.	In Inches. (Approximately.)
10-16	2.555	88.2485	101.8482	115.4479	129.0476	142.6473	156.2470	2.555	10-16
11-16	2.560	88.4944	102.1341	115.7738	129.4135	143.0532	156.6929	2.560	11-16
12-16	2.565	88.7403	102.4200	116.0997	129.7794	143.4591	157.1388	2.565	12-16
13-16	2.570	88.9860	102.7057	116.4254	130.1451	143.8648	157.5845	2.570	13-16
14-16	2.575	89.2316	102.9913	116.7510	130.5107	144.2704	158.0301	2.575	14-16
15-16	2.580	89.4779	103.2777	117.0775	130.8773	144.6771	158.4769	2.580	15-16
31 inches	2.585	89.7247	103.5647	117.4047	131.2447	145.0847	158.9247	2.585	31 inches
1-16	2.590	89.9708	103.8509	117.7310	131.6111	145.4912	159.3713	2.590	1-16
2-16	2.595	90.2175	104.1378	118.0581	131.9784	145.8987	159.8190	2.595	2-16
3-16	2.600	90.4647	104.4253	118.3859	132.3465	146.3071	160.2677	2.600	3-16
4-16	2.605	90.7118	104.7127	118.7136	132.7145	146.7154	160.7163	2.605	4-16
5-16	2.610	90.9592	105.0004	119.0416	133.0828	147.1240	161.1652	2.610	5-16
6-16	2.615	91.2065	105.2881	119.3697	133.4513	147.5329	161.6145	2.615	6-16
7-16	2.620	91.4541	105.5761	119.6981	133.8201	147.9421	162.0641	2.620	7-16
8-16	2.625	91.7016	105.8640	120.0264	134.1888	148.3512	162.5136	2.625	8-16
9-16	2.630	91.9496	106.1525	120.3554	134.5583	148.7612	162.9641	2.630	9-16
10-16	2.635	92.1976	106.4410	120.6844	134.9278	149.1712	163.4146	2.635	10-16
11-16	2.640	92.4461	106.7301	121.0141	135.2981	149.5821	163.8661	2.640	11-16
12-14	2.645	92.6945	107.0191	121.3437	135.6683	149.9929	164.3175	2.645	12-16
13-16	2.650	92.9429	107.3081	121.6733	136.0385	150.4037	164.7689	2.650	13-16
14-16	2.655	93.1918	107.5977	122.0036	136.4095	150.8154	165.2213	2.655	14-16
15-16	2.660	93.4412	107.8879	122.3346	136.7813	151.2280	165.6747	2.660	15-16
32 inches	2.665	93.6900	108.1774	122.6648	137.1522	151.6396	166.1270	2.665	32 inches
32 inches	2.670	93.9387	108.4668	122.9949	137.5230	152.0511	166.5792	2.670	32 inches
1-16	2.675	94.1886	108.7576	123.3266	137.8956	152.4646	167.0336	2.675	1-16
2-16	2.680	94.4384	109.0483	123.6582	138.2681	152.8780	167.4879	2.680	2-16
3-16	2.685	94.6881	109.3389	123.9897	138.6405	153.2913	167.9421	2.685	3-16
4-16	2.690	94.9378	109.6295	124.3212	139.0129	153.7046	168.3963	2.690	4-16
5-16	2.695	95.1880	109.9207	124.6534	139.3861	154.1188	168.8515	2.695	5-16
6-16	2.700	95.4381	110.2118	124.9855	139.7592	154.5329	169.3066	2.700	6-16

Discharge over Rectangular Weirs—Continued.

HEAD, H, On Crest, Measured to still water. See page 20.		DISCHARGE IN CUBIC FEET PER SECOND. WITH TWO COMPLETE CONTRACTIONS.				
In Inches. (Approximately.)	In Feet.	8 Feet Long.	9 Feet Long.	10 Feet Long.	11 Feet Long.	12 Feet Long.
7-16	2.705	110.5029	125.3176	140.1323	154.9470	169.7617
8-16	2.710	110.7946	125.6504	140.5062	155.3620	170.2178
9-16	2.715	111.0869	125.9839	140.8809	155.7779	170.6749
10-16	2.720	111.3792	126.3174	141.2556	156.1938	171.1320
11-16	2.725	111.6714	126.6508	141.6302	156.6096	171.5890
12-16	2.730	111.9636	126.9842	142.0048	157.0254	172.0460
13-16	2.735	112.2563	127.3182	142.3801	157.4420	172.5039
14-16	2.740	112.5491	127.6523	142.7555	157.8587	172.9619
15-16	2.745	112.8424	127.9870	143.1316	158.2762	173.4208
33 inches	2.750	113.1357	128.3217	143.5077	158.6937	173.8797
1-16	2.755	113.4289	128.6563	143.8837	159.1111	174.3385
2-16	2.760	113.7228	128.9917	144.2606	159.5295	174.7984
3-16	2.765	114.0167	129.3271	144.6375	159.9479	175.2583
4-16	2.770	114.3110	129.6630	145.0150	160.3670	175.7190
5-16	2.775	114.6046	129.9981	145.3916	160.7851	176.1786
6-16	2.780	114.8996	130.3348	145.7700	161.2052	176.6404
7-16	2.785	115.1938	130.6706	146.1474	161.6242	177.1010
8-16	2.790	115.4887	131.0072	146.5257	162.0442	177.5627
8-16	2.795	115.7842	131.3446	146.9048	162.4651	178.0254
9-16	2.800	116.0789	131.6809	147.2829	162.8840	178.4869
10-16	2.805	116.3742	132.0180	147.6618	163.3056	178.9494
11-16	2.810	116.6702	132.3559	148.0416	163.7273	179.4130
12-16	2.815	116.9661	132.6937	148.4213	164.1489	179.8765
13-16	2.820	117.2620	133.0315	148.8010	164.5705	180.3400
14-16	2.825	117.5578	133.3692	149.1806	164.9920	180.8034
15-16	2.830	117.8542	133.7076	149.5610	165.4144	181.2678
34 inches	2.835	118.1505	134.0459	149.9413	165.8367	181.7321
1-16	2.840	118.4475	134.3850	150.3225	166.2600	182.1976
2-16	2.845	118.7444	134.7240	150.7036	166.6832	182.6628
3-16	2.850	119.0420	135.0638	151.0856	167.1074	183.1292
4-16	2.855	119.3394	135.4034	151.4674	167.5314	183.5954
5-16	2.860	119.6369	135.7431	151.8493	167.9555	184.0617
6-16	2.865	119.9342	136.0826	152.2310	168.3794	184.5278
7-16	2.870	120.2322	136.4220	152.6136	168.8049	184.9950
8-16	2.875	120.5308	136.7630	152.9970	169.2301	185.4632
9-16	2.880	120.8286	137.1040	153.3794	169.6548	185.9302
10-16	2.885	121.1270	137.4448	153.7626	170.0804	186.3982
11-16	2.890	121.4261	137.7864	154.1467	170.5070	186.8673
12-16	2.895	121.7251	138.1279	154.5307	170.9335	187.3368
13-16	2.900	122.0241	138.4694	154.9147	171.3600	187.8063
14-16	2.905	122.3230	138.8108	155.2986	171.7864	188.2742
15-16	2.910	122.6225	139.1529	155.6833	172.2137	188.7441
35 inches	2.915	122.9220	139.4950	156.0680	172.6410	189.2140
35 inches	2.920	123.2220	139.8377	156.4534	173.0691	189.6848
1-16	2.925	123.5220	140.1804	156.8388	173.4972	190.1556
2-16	2.930	123.8220	140.5231	157.2242	173.9253	190.6264
3-16	2.935	124.1225	140.8664	157.6103	174.3542	191.0981
4-16	2.940	124.4230	141.2097	157.9964	174.7831	191.5698
5-16	2.945	124.7234	141.5530	158.3824	175.2110	192.0414
6-16	2.950	125.0245	141.8969	158.7693	175.6417	192.5141
7-16	2.955	125.3254	142.2407	159.1560	176.0718	192.9868
8-16	2.960	125.6271	142.5854	159.5437	176.5020	193.4608
9-16	2.965	125.9286	142.9290	159.9312	176.9325	193.9338
10-16	2.970	126.2301	143.2744	160.3187	177.3630	194.4078
11-16	2.975	126.5316	143.6188	160.7061	177.7934	194.8807
12-16	2.980	126.8335	143.9639	161.0943	178.2247	195.3551
13-16	2.985	127.1354	144.3089	161.4824	178.6559	195.8294
14-16	2.990	127.4380	144.6547	161.8714	179.0881	196.3048
15-16	2.995	127.7405	145.0004	162.2603	179.5202	196.7810
36 inches	3.000	128.0437	145.3469	162.6501	179.9533	197.2565

TABLE V.

Discharge over Cippoletti's Trapezoidal Weir of Various Lengths and with Various Depths, and Over Rectangular Weirs without Side Contraction.

$$\text{Formula, } D = 3.3\tfrac{2}{3}\ L\ H^{\frac{3}{2}}$$

For conditions see page 15.

Depth of Water on Crest.		DISCHARGE IN CUBIC FEET PER SECOND.						
In Inches.	In Feet.	1 Foot Long.	1½ Feet g.	2 Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	10 Feet Long.
.3	.025	.0135	.0202	.0269	.0404	.0539	.0673	.1347
.6	.05	.0367	.0566	.0754	.1131	.1508	.1885	.3771
.9	.075	.0690	.1035	.1380	.2071	.2761	.3451	.6902
1.2	.10	.1064	.1596	.2128	.3192	.4256	.5319	1.0639
1.5	.125	.1488	.2232	.2976	.4464	.5952	.7440	1.4881
1.8	.15	.1956	.2934	.3912	.5868	.7824	.9780	1.9560
2.1	.175	.2464	.3697	.4929	.7393	.9858	1.2322	2.4644
2.4	.20	.3010	.4515	.6020	.9039	1.2039	1.5049	3.0098
2.7	.225	.3592	.5388	.7184	1.0777	1.4369	1.7961	3.5922
3.0	.25	.4208	.6312	.8417	1.2625	1.6833	2.1041	4.2083
3.3	.275	.4855	.7282	.9709	1.4564	1.9419	2.4273	4.8547
3.6	.30	.5531	.8297	1.1063	1.6594	2.2126	2.7657	5.5314
3.9	.325	.6238	.9358	1.2477	1.8715	2.4954	3.1192	6.2384
4.2	.35	.6972	1.0459	1.3945	2.0917	2.7890	3.4862	6.9724
4.5	.375	.7730	1.1595	1.5460	2.3190	3.0920	3.8649	7.7299
4.8	.40	....	1.2777	1.7035	2.5553	3.4071	4.2588	8.5177
5.1	.425	....	1.3993	1.8658	2.7987	3.7316	4.6645	9.3290
5.4	.45	....	1.5246	2.0328	3.0492	4.0656	5.0820	10.1640
5.7	.475	....	1.6534	2.2045	3.3067	4.4089	5.5112	11.0225
6.0	.50	....	1.7854	2.3805	3.5708	4.7610	5.9512	11.9025
6.3	.525	....	1.9210	2.5614	3.8420	5.1227	6.4034	12.8068
6.6	.55	....	2.0599	2.7465	4.1198	5.4930	6.8663	13.7326
6.9	.575	....	2.2018	2.9357	4.4036	5.8715	7.3393	14.6787
7.2	.60	....	2.3472	3.1293	4.6939	6.2585	7.8231	15.6463
7.5	.625	....	2.4956	3.3274	4.9911	6.6548	8.3185	16.6370
7.8	.65	....	2.6462	3.5283	5.2924	7.0565	8.8206	17.6413
8.1	.675	....	2.8007	3.7343	5.6014	7.4686	9.3357	18.6715
8.4	.7	....	3.9437	5.9156	7.8874	9.8593	13.8030	19.7186
8.7	.725	....	4.1565	6.2347	8.2930	10.3912	14.5457	20.7824
9.0	.75	....	4.3733	6.5599	8.7466	10.9332	15.3065	21.8675
9.3	.775	....	4.5942	6.8912	9.1883	11.4854	16.0796	22.9708
9.6	.80	....	4.8177	7.2265	9.6354	12.0442	16.8619	24.0885
9.9	.825	....	5.0453	7.5679	10.0906	12.6132	17.6585	25.2264
10.2	.85	....	....	7.9154	10.5538	13.1923	18.4692	26.3846
10.5	.875	....	....	8.2669	11.0225	13.7781	19.2893	27.5562
10.8	.90	....	....	8.6234	11.4978	14.3723	20.1212	28.7446
11.1	.925	....	....	8.9850	11.9800	14.9749	20.9649	29.9499
11.4	.95	....	....	9.3516	12.4688	15.5860	21.8204	31.1720
11.7	.975	....	....	9.7233	12.9644	16.2054	22.6876	32.4019
12.0	1.00	....	....	10.1000	13.5667	16.8333	23.5667	33.6667
12.3	1.025	....	....	10.4808	13.9744	17.4679	24.4551	34.9359
12.6	1.05	....	....	10.8666	14.4888	18.1110	25.3554	36.2220
12.9	1.075	....	....	11.2575	15.0100	18.7624	26.2674	37.5249
13.2	1.10	....	....	11.6524	15.5365	19.4206	27.1888	38.8412
13.5	1.125	....	....	12.0518	16.0684	20.0855	28.1198	40.1711
13.8	1.150	....	....	12.4563	16.6071	20.7588	29.0624	41.5177
14.1	1.175	....	....	12.8644	17.1525	21.4406	30.0168	42.8812
14.4	1.2	....	....	13.2764	17.7019	22.1274	30.9784	44.2548
14.7	1.225	....	....	13.6936	18.2581	22.8226	31.9517	45.6453
15.0	1.25	....	....	14.1148	18.8197	23.5246	32.9344	47.0492
15.3	1.275	....	....	14.5410	19.3880	24.2349	33.9280	48.0699

Discharge over Rectangular Weirs—Concluded.

Depth of Water on Crest.		DISCHARGE IN CUBIC FEET PER SECOND.						
In Inches.	In Feet.	1 Foot Long.	1½ Feet Long.	2 Feet Long.	3 Feet Long.	4 Feet Long.	5 Feet Long.	10 Feet Long.
15.6	1.3	....	....	....	19.9603	24.9508	34.9305	49.9007
15.9	1.325	....	....	....	20.5394	25.6742	35.9489	51.3484
16.2	1.35	....	....	....	21.1238	26.4047	36.9666	52.8095
16.4	1.375	....	....	....	21.7123	26.1404	37.9966	54.2808
16.8	1.4	....	....	....	22.3075	27.8844	39.0382	55.7688
17.1	1.425	....	....	....	22.9082	28.6352	40.0893	57.2704
17.4	1.45	....	....	....	23.5128	29.3910	41.1474	58.7820
17.7	1.475	....	....	....	24.1242	30.1552	42.2178	60.3105
18.0	1.5	....	....	....	24.7396	30.9245	43.2943	61.8490
18.3	1.525	....	....	....	25.3604	31.7005	44.3808	63.4011
18.6	1.55	....	....	....	25.9866	32.4833	45.4766	64.9666
18.9	1.575	....	....	....	26.6182	33.2727	46.5818	66.5455
19.2	1.6	....	....	....	....	34.0685	47.6959	68.1370
19.5	1.625	....	....	....	....	34.8702	48.8183	69.7405
19.8	1.65	....	....	....	....	35.6782	49.9495	71.3565
20.1	1.675	....	....	....	....	36.4913	51.0878	72.9820
20.4	1.7	....	....	....	....	37.3111	52.2855	74.6222
20.7	1.725	....	....	....	....	38.1376	53.3926	76.2752
21.0	1.75	....	....	....	....	38.9691	54.5568	77.9383
21.3	1.775	....	....	....	....	39.8074	55.7804	79.6149
21.6	1.8	....	....	....	....	40.6516	56.9121	83.3030
21.9	1.825	....	....	....	....	41.5009	58.1013	83.0018
22.2	1.85	....	....	....	....	42.3577	59.3008	84.7154
22.5	1.875	....	....	....	....	43.2179	60.5031	86.4358
22.8	1.9	....	....	....	....	....	61.7211	88.1780
23.1	1.925	....	....	....	....	....	62.9442	89.9103
23.4	1.95	....	....	....	....	....	64.1720	91.6743
23.7	1.975	....	....	....	....	....	65.4116	93.4452
24.0	2.0	....	....	....	....	....	66.6560	95.2328
25.5	2.125	....	....	....	....	....	72.909	104.289
27.0	2.25	....	....	....	....	....	79.541	113.63
28.8	2.4	....	....	....	....	....	87.619	125.18
30.0	2.5	....	....	....	....	....	93.156	133.07

TABLE VI.

Some Useful Physical Constants.

1 acre	=	43,560 sq. ft.
1 second-foot	=	450 gallons per minute.
1 cubic foot	=	7.5 gallons.

1 cubic foot of water weighs 62½ pounds at average temperature.

1 second-foot	=	2 acre-feet in 24 hours (approx.).
1,000,000 cubic feet	=	23 acre-feet (approx.).
100 California inches	=	4 acre-feet in 24 hours.
100 Colorado inches	=	5 1-6 acre feet in 24 hours.
50 California inches	=	1 second-foot.
38.4 Colorado inches	=	1 second-foot.
1 Colorado inch	=	17,000 gallons in 24 hours (approx.).
1 second-foot	=	59½ acre-feet in 30 days.
2 acre feet	=	1 second-foot per day or .03⅓ second-feet in 30 days.
100 California inches	=	3.97 acre-feet per 24 hours.
1 acre-foot	=	25.2 California miner's inches in 24 hours.
1 second-foot	=	724⅓ acre-feet in 1 year.